CHEMICAL
& METALLURGICAL
ENGINEERING

Unconscious Disarmament

AT THE dinner given by the members of the Technical Association of the Pulp and Paper Industry Prof. MARSTON T. BOGERT of Columbia spoke of "Unconscious Disarmament," and the idea is worth remembering.

Suppose we go ahead and build big battleships that cost $30,000,000 apiece but hold fast to the familiar conservative advice and let chemical industry piffle out. Suppose we heed the demands for their masters of such legislators as senator MOSES and let General PEYTON C. MARCH have his own way and give up our Chemical Warfare Service and organize the defense of our nation without the aid of chemistry. We can have a great navy and big guns and brass bands, and many soldiers drilling, and still be disarmed. We can be disarmed despite immense army and navy appropriations.

In some of the later bombardments of the war as high as 80 per cent of the shells shot contained gas. The German gas, all of it, was made in their dyeworks. The Germans are a war-lusty people, and their present inadequate licking has not taken the taste of it from them. As individuals nearly every one knows Germans who are honest and loyal and trustworthy to the end. As a nation they have shown themselves to be without honor, and that is the reason why, to use a German expression, they are *in Verruf*.

They have destroyed the French coal mines, turning them into great submarine lakes and filling their entrances with explosives, so that the greatest of them cannot be operated before 1932. But even without Silesia the Germans have far more coal than England and Wales. Their facilities for fixing nitrogen, present and under construction, are about twice their industrial requirements. The one use for these products besides industry is munitions of war. Their external debt is forty million dollars, while that of France is six billion dollars. They have no devastated areas, whereas that of France is the size of Massachusetts, Connecticut and Rhode Island combined, and before the war it provided one-fifth of the nation's income from taxes. Even if we do say it with a tinge of jealousy, the Germans' consumption of champagne is said to be greater than that of any other country, and champagne does not indicate poverty. The bets registered at one race meet are reported to have equaled the sum collected in the United States to relieve the starving children of Germany. If the Germans had fed their children and the Americans had bet on their racehorses on this one occasion, the results, so far as the starving children are concerned, would have been the same. We used to think we could make millionaires pretty fast in this country, but they seem to be beating us at that game, too.

Now, as Dr. BOGERT pointed out, the club gave way to the bow and arrow; the arrow to the musket; the ironclad succeeded the wooden battleship, and now the airplane and the submarine have succeeded the dreadnought. You do not need to strike a ship with a bomb to destroy it. A gas torpedo dropped to windward will kill everybody aboard. A thousand pounds of TNT dropped near a battleship will sink it. Chemical warfare, which has only just begun, makes it so easy to destroy a battleship and its crew that the question is arising whether it is worth while to build them at $30,000,000 each. It is not even certain that the biggest navy will control the sea.

Let's take a little lesson from history. In the third century B.C. the Carthagenians ruled the Mediterranean. They had triremes and quinqueremes—i.e., galleys with, respectively, three and five banks of oars. Their naval maneuvers consisted chiefly in ramming the ships and breaking the oars of the enemy. In order to quell the piracy that prevailed they established a station at Messina, and that offended the Romans, and so the Punic wars began. The Romans built galleys provided with a boarding bridge with hooks, called a *corvus*, and manned their ships with soldiers. This was new and unconventional, and the Carthagenian naval authorities knew better. They were conservative in sea warfare and would not adopt newfangled notions. So they lost their navy, and in the end they lost their country so completely that the descendants of their people to this day live in darkness and even their skins are black. They were disarmed at sea by the *corvus*.

We may not like poison gas or submarines, but they are here and the Germans are masters of the arts of making them and using them. Surely we don't want to use them, and we hope it may never be necessary. But if the Germans can break up Poland and Czecho-Slovakia and get Russian man power to fight for them, they are even now prospectively the physical masters of the world.

There are also micro-organisms that are destructive, and it may be recalled that there was an official exportation of anthrax bacilli from Germany into Roumania during the war. It seemed a little too hazardous, even for the Germans, but there is the whole field of biochemistry to call on for means of destruction that has not been brought into general use as yet. We do not fear elephants and lions and tigers or any big animals, but those that are infinitely small have us beaten as soon as they are introduced. And suppose the German people, feeling strong again, should find that the whole world is unwilling to let them dominate. This may be construed into an attack upon the German Will—and we know that the Germans have no reservations in war.

There is just one way, and only one way, to insure against any enemy, and that is—not to think we are doing great things because we spend big money, and

not to heed the peeps of Senators and Congressmen who represent special interests, but to insist upon it constantly, urgently and without any argument or pettifogging, that this country must and shall lead in science. Therein is our safety. It is the only physical guardian of our heritage of freedom. We owe this to the coming generations. To pass the dye bill is the first step.

Developments in the
Army's Nitrogen Policy

ON THE subject of national nitrogen preparedness and the disposition of the Government's Nitrate Plant No. 2 at Muscle Shoals, this journal has consistently supported the position and advocated the views of the Chief of Ordnance and the officers of the Nitrate Division. This broad policy was originally determined and is still maintained on the ground that national welfare is paramount to private interest. We believe the position is sound, notwithstanding partisan pleading to the contrary. Nitrate Plant No. 2 was built for the Army in an emergency, and the cyanamide process was adopted because it was then, as it still is, the only process of nitrogen fixation which has been brought to commercial utility in this country. It was recognized when the plant was built that its disposition after the war might be a delicate problem involving a conflict of opinion between public and private interest. But having been built for the Army, and being subsequently regarded by the Army as necessary to the national defense, it seemed rational to take steps to secure it for that purpose.

After the Armistice, when the Army's plans for future preparedness assumed a magnitude commensurate with its recent experience in the World War, it seemed advisable and necessary to advocate continued Government ownership and operation of Nitrate Plant No. 2. It is true that this plan would have involved production of fertilizer materials, but that would have been only an incidental result and not the primary purpose. There were much broader plans behind the project looking toward research and experimentation that would give the United States the premier position in nitrogen fixation instead of the less than subordinate rank it now holds. Furthermore it was the avowed purpose of the Chief of Ordnance to control and operate the plant only until private capital should establish in this country a nitrogen-fixation industry on which the Army could rely in case of emergency. That purpose still prevails. All this, however, is now a matter of history, for the plan was defeated in Congress through the intervention of private interests. Even had it been acted on favorably, the legislation would have been ineffective in view of the decision of Congress to discontinue work on the Wilson dam and power plant at Muscle Shoals, on the completion of which the economic operation of the nitrate plant is dependent.

All of these items, together with a recent revision of the plans of the Army for raising and equipping a reserve force and putting it into action, lend a new aspect to the whole matter. Contemplating a smaller reserve force, it is felt that the present supply of Chilean nitrate will suffice for the production of munitions as rapidly as men can be trained and equipped—*provided* that Nitrate Plant No. 2 be put in stand-by condition and held ready for emergency. The first year's production of this plant would augment the Chilean nitrate reserve and suffice until new plants could be built. And probably the latter could be accomplished as rapidly as further forces could be raised, trained and equipped. In view of these revised plans it is unnecessary to insist on Government operation of the plant at Muscle Shoals, but merely to put it in stand-by condition and hold it at the disposal of the Army.

There remain two other phases of the nitrogen problem which are of national concern: the completion of the Wilson dam and the continuance of the work of the Fixed Nitrogen Research Laboratory at American University. With the Secretary of War rests the future of these projects. As to the first he has announced that if he can find private business interests that will assure him of the commercial utility of the dam and power plant and will agree to take it over and operate it when completed, he will recommend to Congress the appropriation of the necessary funds, estimated at about $30,000,000, for its completion. If he cannot assure himself on these points, he will not recommend an appropriation.

With the research work, however, we are more concerned. The laboratory has done excellent work and is well manned and directed. Its research has been of value not only to the Government but also to the future success of a private nitrogen industry in the United States. Some of its experiments have been more exhaustive and complete than any heretofore conducted in this country. Agriculture as well as warfare will profit from its investigations. Considering the fact that money is already available for work beyond July 1, to which date Secretary BAKER authorized the laboratory to continue its investigations, there appears to be no reason why the place should be closed. To do so would mean the great loss always incidental to scattering an excellent staff. We believe, therefore, that Secretary WEEKS should by all means authorize the continuance of the research laboratory. In a recent interview by the editor of CHEMICAL & METALLURGICAL ENGINEERING he was asked as to his policy in this matter and replied that while he had not as yet reached a decision, his "personal inclination would be to continue the work." This we hope will be his final decision.

Why Hire
A Chemist?

THE Research Information Service of the National Research Council has just received a communication from a chemical manufacturing concern, the name of which we shall not mention for rather obvious reasons, which says: "We would appreciate it, and thank you, if you would kindly furnish us with a working formula for the manufacture of meta-nitraniline. We are aware that the base of this product is dinitrobenzene, but if you could furnish us with a formula for the manufacture of the above product from nitrobenzene and then follow as nearly as possible the continuation for the finished product of the meta, we would appreciate it." Of course they would!

This company, which, by the way, advertises itself as a firm of "manufacturing chemists," goes on to say that it has good information from certain industrial text books, but finds that these books do not give "clearly" what the company wants. It even has the frankness to say, "We are aware that if we had a qualified chemist this product could be worked out, as we know there is not much to it."

It is gratifying to learn that the Research Council in replying to this inquiry with appropriate frankness told

this company that it should go and hire a chemist or at least a consulting chemist for this particular task.

Absurdity reaches a maximum when a firm undertakes so complicated a task as dyestuff manufacture without the assistance of experienced and expert chemists. It is little wonder that American dyes at times come into bad repute if they are made by this sort of "manufacturing chemists." The firm no doubt can conduct the commercial end of the business which it advertises as "importer and dealer in dyestuffs and chemicals" without the intimate control that manufacturing processes require of a chemist. But until it, and others like it, learn to keep out of the manufacturing business unless it engages qualified employees to direct the work we can expect serious results for the industry as a whole.

Universities
And Research

CIRCUMSTANCES prevented editorial discussion last week of the thoughtful contribution of Messrs. HOSKINS and WILES to the unsettled question of the relation of our universities to scientific and industrial research. Different solutions of the problem are being sought and advocated in different institutions, and we have recently added our own views in the matter, which are to the effect that the university laboratory is the place for scientific rather than industrial research, and that the consulting engineer rather than the university industrial fellow is the logical agency for the investigation of the technical problems of industry. Broad exceptions may be made to this general policy, but in its essence we believe it to be sound. Nevertheless we are glad to have the opposing views of Prof. ROBERT E. WILSON, director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, which we publish elsewhere in this issue.

As we read the communications of Messrs. HOSKINS and WILES and Prof. WILSON it seems likely that we can reach agreement on several points: First, that the appropriate place for pure science research is the university laboratory; second, that we need a great increase in this kind of research for the ultimate benefit and use of industry; third, that the university needs financial support for the execution of this work; and fourth, that since industry is the ultimate beneficiary of the results, it is the logical source of the needed support. At this point, however, our paths diverge, and the crux of the matter becomes the *modus operandi* whereby industry shall be induced and enabled to make the necessary contributions. Prof. WILSON would have it done by establishing industrial fellowships that would earn an adequate return for the service rendered. This takes no account, however, of one phase of the subject which we have emphasized before—viz., the unfair competition between the university and private consultants who, indeed, are the university's primary product. On this score the plan is indefensible, Prof. WILSON himself naïvely admitting the advantages which the university enjoys over the man who is making his livelihood by selling technical knowledge and service. The "Tech" plan undoubtedly has merit, but in our judgment it is not the best solution of the problem.

The proposal of Messrs. HOSKINS and WILES, on the other hand, is novel and full of promise, although the authors themselves recognize certain pitfalls in its execution and the safeguards that must be thrown about

it. The personal element of administration enters strongly into the success or failure of the scheme. They believe, however, that university scientific research can best be fostered and supported by patenting the discoveries of the research staff, granting to industry non-exclusive licenses for the use of the inventions, and applying the royalties therefrom to the further support of scientific research by paying salaries commensurate with the ability demanded and reasonably comparable with those paid for industrial work of the same caliber.

Students of this plan will be struck by its similarity to the one recently proposed for handling the patentable inventions of Government employees. In both cases we find scientists engaged in public or quasi-public work, making patentable discoveries as a direct consequence or byproduct of their researches. There is a marked difference, however, when it comes to administration of the resulting inventions. In the case of the Government the work is done at public expense and the results should be freely available to all without discrimination in granting licenses. In the university, according to the present plan, the invention becomes the property of the institution and its use may be licensed with propriety, though here also the authors of the idea recognize the necessity of preventing monopoly, the chief object in licensing being to assure an income for the continuation of research. As a whole the plan represents an advance over any thus far proposed and merits consideration and a fair trial, at least until a better one is suggested.

Never Built,
But Building

INDUSTRIAL plants operating in the production of materials where chemical processes are involved are ever in a state of flux as regards the layout of machinery, apparatus and buildings. New findings through both research and accidents of operation are continually showing that a rearrangement of the flow or an addition of new features will effect savings in production which more than offset the cost for reconstruction of existing plant.

The construction foreman has become a permanent member of the staff of every important chemical manufacturing institution and is usually an important one. He is continually employed in adding towers, flues and buildings, or placing new apparatus designed to improve the plant. His repairs often amount to a complete rebuilding of old units. This condition is accounted for when it is borne in mind that the industry is developing at an enormous rate and on a broadening scale and that the value of scientific control is just coming to be recognized fully by the directors of those industries in which timeworn, so-called secret methods fail to meet new technical competition.

This changing of equipment does not always call for large expenditures to effect greater savings, but changes are nevertheless essential to continued economic health. When all industry awakens to this condition common to chemical industries—namely, that a change of mind is a sign of progress, and during times of business depression with consequent strenuous competition is absolutely necessary to the existence of many concerns —the return from such periods to normal conditions can never be long delayed.

There is material for thought then in the fact that chemical plants are never built, but building.

Readers' Views and Comments

Birkeland-Eyde Arc Process of Nitrogen Fixation

To the Editor of Chemical & Metallurgical Engineering

SIR:—The Norsk Hydro-Elektrisk Kvelstofaktieselskab of Christiania, Norway, which owns the big nitrogen plants at Notodden and Rjukan, wishes to make the following statement:

It appears from the stenographic report of the "hearing before the Committee on Agriculture and Forestry, United States Senate, on S. 3,390," that the president of the American Cyanamid Co., Frank S. Washburn, has obtained a hearing before the committee and that he has taken the opportunity at this hearing to try to reduce to nothing the importance of the arc process, particularly the Birkeland-Eyde process.

We wish to state in this connection that we do not, on principle, as a rule reply to erroneous or refutable statements about the methods used by our company. We therefore do not see any reason why we should, generally speaking, take any notice of Mr. Washburn's statements whatsoever, especially as it must be clear to everyone conversant with the development of the atmospheric nitrogen industry that Mr. Washburn's version of the facts is incorrect.

We think, however, it only proper to attend to Mr. Washburn's statement concerning the utilization of the arc process in America, and which he attributes to Sam Eyde (page 174 of the hearings). We have placed this matter before Mr. Eyde, who in reply maintains that he has never expressed himself to Mr. Washburn in the manner indicated. On the contrary, Mr. Eyde states that he has been striving for years to open the eyes of the American industrial and financial interests to the great advantage the Birkeland-Eyde process would proffer to America.

We further wish to point out the following statement, made by Mr. Washburn (page 129 of the hearings):

> Now there is an enormous Norwegian plant, as you know. The representative of the banking interests which own that plant has been to see me quite lately, within the last two months; he was sent over here for the purpose of consulting on what practical use that plant might have. Out of this war they amortized the plant, the full cost of the plant, which was enormous.

No representative of the banking interests of our company has had a consultation of this kind with Mr. Washburn. Therefore this statement by Mr. Washburn is untrue.

As to the rest of Mr. Washburn's statements concerning the arc process and our plants, all we care to say is that we find it quite superfluous to reply to them at all. HARALD BJERKE.

Director General,
Norwegian Hydro-Electric Nitrogen Co.,
Christiania, Norway.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reference to the criticism made by Harald Bjerke of the Norwegian Hydro-Electric Nitrogen Co. on the testimony of Frank S. Washburn before the Senate Committee on Agriculture and Forestry with reference to S. 3,390, I think Mr. Bjerke has attached undue emphasis to certain isolated sentences which when removed from the context could easily lead to erroneous conclusions. Thorough and careful reading of Mr. Washburn's testimony shows that not only did he appreciate the value of the arc process by at one time negotiating for its American rights, but I know that even many years later he publicly conceded its commercial value, particularly for the production of nitric acid under certain economic conditions. I am certain Mr. Washburn has in no sense attempted to discount the arc process as a fundamental proposition, but rather to show that as the arc process is at present developed it can play no important part under existing conditions and power costs in the fertilizer industry of this country.

That Mr. Washburn is correct in this analysis I think has been adequately borne out by the recommendations of the various commissions and bureaus which formulated a governmental nitrogen program. No recommendations were made in any of these reports that we install such arc process, but the conclusion does appear in them that the arc process is inapplicable to American conditions. The fact that the arc process has made no headway in this country in the nearly twenty years of its existence, although several attempts at installation have been made, further bears out Mr. Washburn's conclusions in a most effective manner.

With reference to the statement of the representative of certain foreign bankers interested in the Norwegian plant, I was present at this conference and in fact held several conferences with this French representative and take issue with Mr. Bjerke as to the truthfulness of Mr. Washburn's statement in this respect.

As a controversy over such matters of fact are trespassing upon the courtesy of the editor of such a journal as this, I should be very pleased to take up the matter personally with Mr. Bjerke or his representative and place before him names, dates and subject matter of conferences held with the individuals referred to.

New York City. W. S. LANDIS.

Prof. Milton Whitney and Nitrogen Fixation

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with my statement in CHEMICAL & METALLURGICAL ENGINEERING for April 6, 1921, concerning the present status and future plans of the Fixed Nitrogen Research Laboratory I wish to call your attention to the fact that prior to the foundation of this laboratory governmental research on nitrogen fixation had been in progress for a number of years under the direction of Prof. Milton Whitney, Chief of the Bureau of Soils. It was due to Prof. Whitney's far-sightedness that the potential seriousness of the nitrogen problem to America was originally appreciated by the Government. His bureau started research along this line as early as 1911, and this work has continued until the present day.

At the time when the War Department became vitally interested in nitrogen fixation from the munitions point of view Prof. Whitney and his colleagues generously co-operated with the Ordnance Department,

and this co-operation was continued after the foundation of this laboratory. At the present time a portion of the work at the Fixed Nitrogen Research Laboratory is carried out under the direction of the Bureau of Soils and by investigators carried on their payroll. It is unfortunate that no mention of this assistance was made in the recent article which appeared in CHEMICAL & METALLURGICAL ENGINEERING describing the work of the Fixed Nitrogen Research Laboratory. The omission was due to the fact that the article in question was taken from a report made by the Director to the War Department, which dealt only with the immediate interests of the Ordnance Department.

In the future more emphasis will be put on other methods of nitrogen fixation, and as a matter of fact for some time the laboratory has been planning work on the cyanide process. RICHARD C. TOLMAN.

Fixed Nitrogen Research Laboratory,
Washington, D. C.

Function of Educational Institutions in Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—A recent editorial in your columns (Feb. 16), entitled "The Function of Educational Institutions in Research," expressed three opinions from which there can be no reasonable dissent. These may be concisely stated as follows:

1. The primary function of the university is to educate its students.

2. University laboratories are best fitted to carry out fundamental scientific research, as distinct from industrial research.

3. There is great need for more such scientific research.

However, in drawing from these premises the conclusion that university laboratories should in general not carry on industrial research one essential point appears to have been overlooked—namely, how are funds to be obtained to carry on this desirable large amount of scientific research? Assuredly the universities in their present financial condition cannot do so to any large extent, nor are the salaries and spare time of the university professors adequate to enable them to carry on any considerable amount of such work. Theoretically, the industries themselves might well support such fundamental research at the universities, but with a few notable exceptions they have not done so.

Under the circumstances, therefore, the most promising method of securing the funds required for purely scientific investigations appears to be to *earn* them. This can readily be done by carrying on industrial research for outside companies—not on a low cost basis such as is frequently employed, which is manifestly unfair to outside commercial laboratories, but on a basis which will enable the laboratory to carry on an almost equal amount of fundamental scientific work which is to be published. In other words, the charges should be fully equivalent to those charged by high-grade commercial laboratories for industrial research; but the amount which would normally go to profits, taxes, rent, etc., in such a concern would here be devoted to the scientific research of which there is so much need.

From an *educational* standpoint, as well, this method of procedure would appear to be justified. Certainly one of the most important functions of a university or technical school is to train men for *industrial* research, and no satisfactory method of giving such training has yet been found except to have the men *do* industrial research under competent direction and with adequate library and laboratory facilities. Such a university laboratory should never endeavor to build up a large permanent staff of experienced men but rather to keep a nucleus of such men, who also do some teaching, and have the main bulk of the research handled by men who remain for one, two or three years after graduation and then go into industrial positions—frequently with the companies for which they have been working.

The presence of such work in a university laboratory also has a beneficial influence in keeping the university in close touch with recent industrial developments and suggests a large number of thesis and graduate research problems which are much more attractive to the average student than the more typical university problems—especially compared with the mere determination of physical constants, which your editorial suggests as being one of the proper functions of a university laboratory.

Several university laboratories are already operating successfully on this basis—for example, the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, has grown within two years to number twenty-five full-time men, and work is being carried on for about fifteen large industrial concerns. The laboratory makes it a principle not to undertake analytical or purely plant problems, but only the more fundamental type of investigation, which bids fair to continue over a considerable period, as the laboratory believes it can render its best service to industries along these lines. It frequently works in close co-operation with the research laboratories of large industrial concerns in attacking problems of major importance. Handling this industrial research has made it possible to carry on about four times as much fundamental scientific work and to train six times as many men as would otherwise have been possible. Furthermore, several of the companies for which work is done have given permission for the publication of results secured at their expense.

Some such basis of carrying on industrial research in university laboratories would therefore appear to be justified on the very premises on which your editorial based its objections. ROBERT E. WILSON,

Research Laboratory of Applied Chemistry, Director.
Massachusetts Institute of Technology,
Cambridge, Mass.

Practical Jokers Among Workmen

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have just read with interest the article on "Practical Jokers Among Workmen" in the April 6 number of your magazine. I am sure that everyone interested in safety work will agree with the author.

I would like to point out that in two of the cases he mentions the accidents might have been avoided if the machinery had been properly guarded, in one case where a man's arm was torn off and in another where a woman's scalp was torn loose by moving belts. Modern safety practice requires that all belts with which it is possible to come in contact be protected by adequate guards.

Carelessness can never be completely prevented and guards should always be placed around moving parts that can in any manner cause accidental injury.

HORACE F. LUNT.

State Bureau of Mines,
Denver, Col.
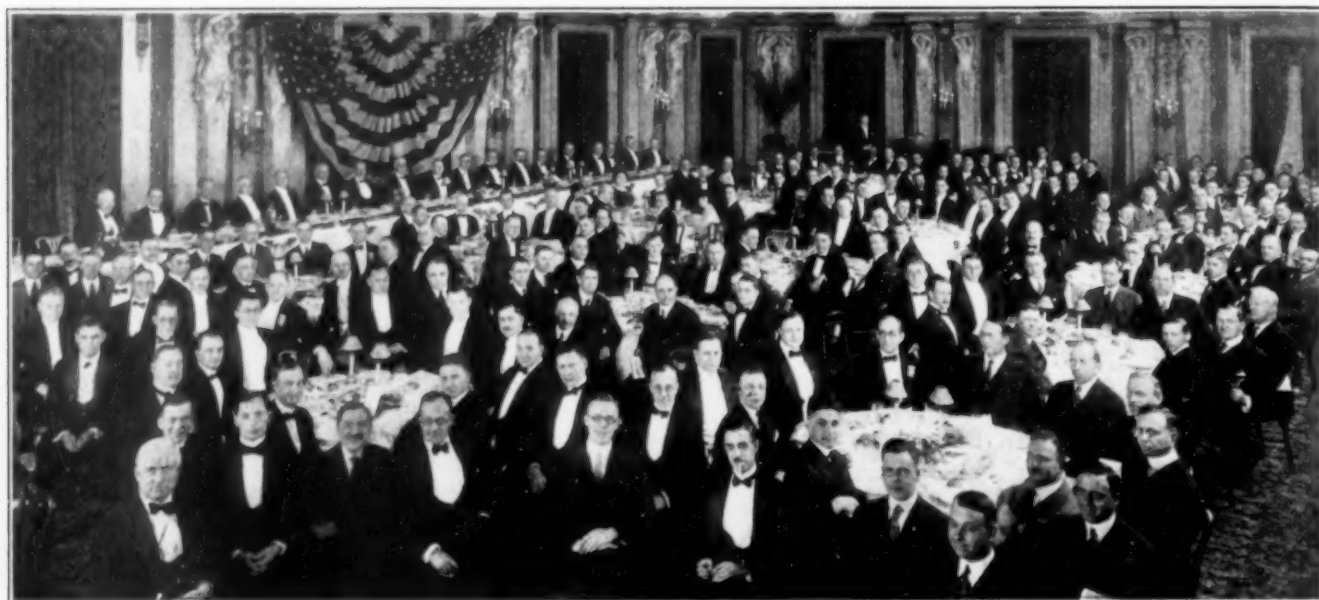
T.A.P.P.I. BANQUET AT THE WALDORF-ASTORIA, NEW YORK, APRIL 15, 1921

Sixth Annual Meeting of T.A.P.P.I. Held in New York

Technical Association of the Pulp and Paper Industry Holds Convention at the Waldorf-Astoria to Discuss Pulp and Paper Technology and Plant Operation Problems

DURING the week of April 11 about one-tenth of the technical personnel of the American pulp and paper industry gathered in New York to attend the meeting of their association. In the presidential address Raymond S. Hatch drew attention to foreign appreciation of the value of T. A. P. P. I. by the institution of similar organizations both in Great Britain and France. President-elect George E. Williamson reported that rapid progress was being made in the preparation and publication of the series of textbooks on "The Manufacture of Pulp and Paper." Vols. I and II, dealing with the preliminary sciences, are now available and Vol. III, on the manufacture of pulp, will appear this fall.

The activities of the association are directed by fifteen committees. Reports and addresses on technical topics pass through them to Secretary Thomas J. Keenan, who publishes them in the *Technical Association Papers*. As limitations as to space require that only brief notes on the major topics be made here, the reader wishing more elaborate details is directed to the extensive report of the meeting in the April 14 issue of the *Paper Trade Journal*, pp. 189-263 and 335-339.

NEW HALL PROCESS OF GRINDING WOOD

A 50 per cent saving in sulphite pulp beater furnish is claimed in paper mills using the Hall process ground wood pulp. The surface of the stone is burred, giving grooves through which the fiber can escape before being reduced to wood flour. About 250 lb. of pulp per cord is gained at the same time. Experiments at the St.

Regis Paper Co. have been under way since 1914. Steam cooking has been found advantageous both in softening the wood and in giving a sterile pulp.

EFFECT OF VARIABLES ON BLEACHING EFFICIENCY

Bleaching powder was shown to give best results at temperatures up to 120 deg. F., with stock consistency around 7 per cent. Variations of around 40 per cent in bleach were obtained with lower temperature concentrations of pulp, using 10 lb. of powder per 100 of pulp. This is actually a function of bleach concentration and should be further studied with variations in acidity in bleaches made direct with chlorine and bases other than lime.

EVALUATION OF LIME BY CAUSTICIZING TEST

Some time ago Martin L. Griffin suggested that the soda ash value should be taken on the lime supplies to determine the causticity. As is well known, lime burned and sintered in an electric furnace is inert even to hydrochloric acid, and even kiln-burned lime can be dead-burned to a greater or less degree according to the magnesia and other flux content. Tests on lime with 93 per cent CaO were submitted, showing 86 per cent soda ash conversion, and limes with as low as 63 per cent conversion were mentioned, the equilibrium being a function of reaction time.

SHORTENING SULPHITE DIGESTION

The Forest Products Laboratory has recently run semi-commercial trials of forcing sulphite liquor into

the charge by preliminary air pressure. Rapid penetration was obtained so that digestion temperatures could be applied much sooner, with considerable saving in time. The combined SO₂ used was too low to give results that should be had with normal operation. High-pressure digestion is undoubtedly going to come more and more into practice and be limited only by safety considerations.

A Study of Casein

The committee on coated paper gave a set of specifications and tests on casein, which should be free from lumps when dissolved in an alkaline soda salt such as borax or carbonate, be in a sterile condition free from mold or decomposition products, and bond china clay in a 6 to 7 per cent mixture to furnish the required coating adherence. Tests for solubility, strength, moisture, color, odor, acidity, insoluble matter, ash, alkali, starch, viscosity and grease were described.

Sulphite Committee Discusses Superheated Steam

The discussion by the sulphite committee centered on the use of superheated steam. Trials in the past indicate that there are chemical advantages which are more or less offset by mechanical difficulties in the boiler house and steam delivery system. Insulation of digesters is being tried out in a few plants, and while no leaks have yet been reported, it is felt that no difficulty will be found in catching them. Partial insulation leaving the base exposed was not thought to be desirable, due to the temperature strain that would be induced, though one plant is trying it out.

Longworth Bill Indorsed

The committee on dyestuffs reported that diminishing trouble was being experienced with paper colors and reported a resolution indorsing the Longworth bill which was voted upon and passed in the assembly.

Bibliography

The committee on bibliography is preparing a reading list on sulphate pulp, marbled papers, dyeing of pulp, drying of paper, cigarette papers, analytical procedures and paper textiles. About twenty-five lists have been submitted in the past making all published facts available without effort in library search. Clarence J. West, chairman of the committee, is now located with the National Research Council at Washington and will be glad to receive and reply to any inquiries regarding bibliographies on pulp and paper subjects.

Waterwheel Efficiencies

Prof. Charles M. Allen of Worcester Polytechnic Institute described the use of the Alden dynamometer in the water-power-driven ground wood pulp mill. He spoke of bad practice and cataloged case after case where poor efficiencies were being obtained on down to where the water turbine was in circuit with steam and actually being driven as a pump—consuming power instead of delivering it. All water-power equipment should be frequently tested to be maintained in an efficient condition.

Use of Waste Heat in Ventilation

The Briner economizer and heat exchanger countercurrents the hot exhaust air from the paper rollers to the incoming supply, thus affording dry air from the outside at any required temperature. A steam radiator is in circuit for use when sufficient heat is not obtainable from the exhaust due to shutdowns and interruptions in operation. A cold air shunt is also installed to make temperature regulation possible.

The Allen Weightometer

The Allen weightometer was described by E. J. Trimbey and is designed to weigh and record continuously anything from chips to liquor. Six triangular open pockets set in the form of a hexagon drum revolve in such a way that a set load releases each when filled and automatically unloads and records each filling during the revolution.

Paper Moisture Content Indicator

Dr. C. B. Thwing demonstrated a beam balance designed to show moisture percentage direct without calculation. The accuracy of the instrument depends on the constancy in the weight of stock which is calibrated against a dried gage piece. As the bond in paper is influenced in strength and other physical properties by the moisture content, it is essential that the moisture content should be tested in conjunction with these other tests.

New Sulphur Plant Described

The Bureau of Mines moving picture of the Texas Gulf Sulphur plant at Matagorda, Tex., visualized the process by which this important raw material is mined in quantities sufficient to supply the markets of the entire world. The liquid sulphur is pumped for miles in steam-jacketed lines, stored in 170,000-ton vats and shipped from the port of Galveston, which is near by. The record capacity of this plant is reported as 2,500 tons per day of commercially pure brimstone averaging 99½ per cent sulphur. The purity is probably due to the gypsum source, which is free from selenium and arsenic.

Banquet

Tuesday night was set aside for the annual feast at the Astor, which was so attractive that we are publishing the photograph by way of ornament. Judge Charles F. Moore was toastmaster and introduced each speaker with a little prelude tale. We are commenting editorially on the principal talk of the evening by Prof. Marston T. Bogert. Ellwood Hendrick aroused the greatest amusement with his chemistry and psychology of odor and smell. Philip T. Dodge presented his views on what degree of finish the raw recruit from the technical schools should have to be welcome in the mills of the International Paper Co. Mr. Dodge desires that paper technology and manufacturing practice be taught to the student, and of course this can be and is carried out after a fashion in a few technical schools, but the big question is: Has the manufacturer any right to push all the burdens of such education on to the schools? We would like to present the views of the technical men at the round tables, but think it enough to state that very few agreed with the speaker.

Fall Meeting

The next meeting will be held in September in Washington, where the Bureau of Standards and Government printing plants will be inspected. An excursion will be made to the plants in the Wilmington and Philadelphia districts at the conclusion of the meeting.

Residual Aluminum Compounds in Water Filter Effluents

Theoretical Considerations Indicating the Influence of the Hydrogen Ion Concentration on the Solubility of Aluminum Hydroxide—Various Conceptions of Aluminum Sulphate Reactions With Natural Alkaline Waters

By ABEL WOLMAN* AND FRANK HANNAN†

ALUMINUM sulphate as a coagulant has been employed for such a long term of years in our water supplies that it would appear to be unnecessary to discuss at this late date any of the peculiarities of its reactions. That such discussion is desirable, however, is clear, when we view in retrospect the development of certain concepts of chemical transformations. As the fields of chemistry and physics become better explored there gradually appears a realization of the continual energy of reactions. The assumptions of rigidity and irreversibility of the interactions of substances need to be abandoned. With such assumptions, it becomes necessary also to discard some of the "fundamental truths" which no longer appear either "fundamental" or "true."

In a number of respects, orthodox conceptions of the action of alum in water seem to require some modification and extension. Such changes in viewpoint may be particularly desirable at this time, when discussion in waterworks fields has again reverted to the problem of residual alumina in filter effluents. For this reason the writers considered it a fruitful task to attempt in this paper to develop as briefly though as accurately as possible an understanding of the mode of action of alum as a coagulant. In such a development the causes of certain associated phenomena, such as disappearance of flock, positive reaction for alumina in filter effluents and imperfect coagulation with low alkalinity, may also appear. For purposes of clarity it is well to point out that in the discussion to follow we are not concerned with the passage, through filters, of undecomposed aluminum sulphate due to insufficient alkalinity or of flocculated hydrate through breaks in filter beds. In other words, our discussion refers to difficulties inherent in natural processes and not to those resulting from unintelligent application of chemicals or operation.

In order to provide for an orderly presentation of the subject, the writers have decided to devote this paper to theoretical considerations, with only such additional data as will be necessary to clarify some of the ideas presented. The experimental proof of some of the hypotheses here set forth is still lacking. One of the important purposes of this discussion is to call forth a greater amount of experimental work in this field than has so far been accomplished. A number of the facts should be tested out in routine practice, so that large-scale findings may substantiate or refute laboratory suggestions emanating from this and other fields. If such a program were carried out, the various phases of the alum problem might be satisfactorily solved. These phases include: (*a*) theoretical considerations, (*b*) experimental data, (*c*) conclusions, (*d*) significance of results (sanitary, physiological, etc.). Our contribution,

as we have stated before, is to be restricted to (*a*)—theoretical considerations. Perhaps in the course of time the supporting material for (*b*), (*c*) and (*d*) will be forthcoming.

Aluminum Sulphate Reaction—Usual Conception

The simplest and most popular conception of the reaction of aluminum sulphate with the natural alkalinity of water is given by the following typical equation:

$$Al_2(SO_4)_3 + 3CaCO_3H_2CO_3 =$$
$$Al_2(OH)_6 + 3CaSO_4 + 6CO_2, \text{ or}$$
$$Al^{+++} + 3HCO_3^- = Al(OH)_3 + 3CO_2$$
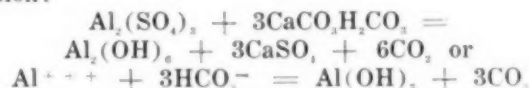
This rigid transformation is usually accepted as approaching the average state of affairs when "normal" conditions obtain. The above equation has been responsible for the oft-repeated statement that "if sufficient raw water alkalinity is present, there is no excuse for the passage of aluminum compounds through filter beds." The simplicity of the reaction has been so frequently emphasized that the impression has been gained by the average filter plant operator that when the coagulum, $Al(OH)_3$, is not instantly and continually formed, the treatment is either careless or faulty. When inquiry, however, among many operators elicits the information that such difficulty as ineffective flock formation and residual alumina in filter effluents are by no means rare occurrences even with plenty of alkalinity, it seems wise to search for causes in other places than poor operation.

Such a search demands at once a reconsideration of alum reactions. Since the study of such reactions has been retarded in the waterworks field by the general hesitancy to question orthodox beliefs, it is necessary to pursue our inquiry into other channels. When this is done, two important series of data appear. These series are in conflict as to the nature of the compounds resulting from alum reactions, but are in complete agreement as to the absence of rigidity of state of any particular aluminum compound. In other words, we must pass from a viewpoint in which alum reactions result in stationary phenomena to one in which they appear as mobile, delicate equilibria. With such a new viewpoint, the formation of an insoluble coagulum as $Al(OH)_3$, when aluminum sulphate is added to water, becomes a desirability, but not necessarily an eventuality. Our problem now becomes to determine those factors which regulate the reaction in such manner that the desired result, an insoluble complete coagulum of $Al(OH)_3$, is obtainable.

Recent Interpretations Based on Hydrogen Ion Concentration

The important characteristic of recent conceptions of $Al_2(SO_4)_3$ reactions is to be found in the realization

*Maryland State Department of Health, Baltimore, Md.
†Toronto Water Filtration Plant, Toronto, Canada.

that the formation of $Al(OH)_3$ is a reversible progressive reaction, dependent upon a number of conditions, the most important of which is probably the hydrogen ion concentration or p_H value of the solution in which one is working. The nature of the solutions obtained, however, when aluminum hydroxide is dissolved in the presence of acids or bases has been the subject of much discussion. The underlying hypotheses of these discussions may be divided into two classes. In the first case, the solution of $Al(OH)_3$ is ascribed to processes of peptization or change in physical structure of $Al(OH)_3$, but not to change in chemical composition. The second school of thought bases its understanding of the processes entirely upon the hypothesis that the changes taking place when $Al(OH)_3$ is formed and redissolved are due to variations in chemical combination. The contrasting viewpoints emphasize changes in physical state as against changes in chemical combination. The salient features of each conception are outlined at some length below, in order to demonstrate that, whatever viewpoint is accepted, one must reach the conclusion that the complete formation of the insoluble $Al(OH)_3$ in water is by no means as frequent an accomplishment as has been tacitly assumed.

CHANGES IN PHYSICAL STATE

The evidence supporting the hypothesis that $Al(OH)_3$ may be redissolved in solutions through the increase of hydroxyl ions, because of a process of peptization or subdivision of particles, is by no means complete. Mahin, Ingraham, and Stewart,[1] for example, conclude that aluminum hydroxide should not be considered as amphoteric since they claim to have established by the measurements of the heat of solution of aluminum hydroxide in sodium hydroxide, of the quantitative relations between ammonium nitrate and sodium aluminate and observations made upon the electrolysis of sodium aluminate that the colloidal properties of aluminum hydroxide play a far more important part in conditioning its solubility in bases and acids than the possible formation of aluminates. In addition, Chatterji and Dhar[2] state:

"In the case of the action between sodium hydroxide and the hydroxide of copper, chromium, lead, zinc, aluminum and mercury, the following results are obtained. The conductivity of a solution of caustic soda did not appreciably change on the addition of hydroxide of chromium, aluminum, lead and mercury, while in the case of zinc the resistance of the caustic alkali solution appreciably increased when zinc hydroxide was dissolved in it. Hence we can conclude that the solutions of aluminum hydroxide, chromium hydroxide, lead hydroxide, mercury hydroxide and copper hydroxide are cases of true peptization and not of chemical combination. On the other hand, in the case of zinc hydroxide, we get more of chemical combination than of peptization. Or, in other words, the major part of the hydroxides of Al, Cr, Cu, Pb, Hg exists in sodium hydroxide solution as a colloid, while the major part of zinc hydroxide remains as a zincate. . . . Similarly the hydroxides of Al, Fe and Cr form colloidal solutions in acetic acid, while zinc hydroxide forms zinc acetate."

The above statements give a fair representation, it is believed, of the hypotheses presented by the adherents of the "peptization" theory. It is important to emphasize that these authors and others have demonstrated the ephemeral character of the insoluble $Al(OH)_3$. They support simply one explanation of the cause of the solution and precipitation of the hydroxide—namely, that due to change in physical structure because of some effect of hydroxyl ions. They disagree with the second class of workers, not on the fundamental idea of the instability of the insoluble $Al(OH)_3$, but only on an explanation of the cause of this instability.

CHANGES IN CHEMICAL CONSTITUTION

The basis of the explanation of the change of state of $Al(OH)_3$ as due to a change in chemical constitution may best be indicated by the following quotation from Stieglitz:[3]

"Aluminum hydroxide dissolves in acids. From its solution in hydrochloric acid, an aluminum salt, aluminum chloride, $AlCl_3 6H_2O$, is obtained. It also combines with strong bases, dissolving, for instance, in a solution of sodium hydroxide and forming an aluminate, $NaAlO_2$ . . . According to the best knowledge we have on the subject, the molecule of aluminum hydroxide has the following structure or arrangement of its atoms $Al(-O-H)_3$. It is readily seen that the cleavage of the molecules may produce either aluminum and hydroxide ions, characteristic ions of a base, or aluminate and hydrogen ions, characteristic ions of an acid:

$$Al^{+++} + 3OH^- \rightleftharpoons Al(-O-H)_3 \rightleftharpoons$$
$$AlO_2^- + H^+ + H_2O."$$
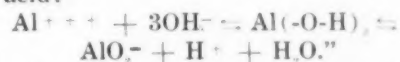
Loeb[4] further adds that "it is obvious that between the action of acids and of bases producing these two types of electrolytic dissociation there must be one hydrogen ion concentration in which aluminum hydroxide is practically neither able to form Al^{+++} nor AlO_2^- ions, and this would be the isoelectric point. The significance of this statement will appear later in the discussion.

Wolfgang Pauli[5] recently strengthens this conception by concluding, as a result of an exhaustive physicochemical analysis, that the aluminum hydroxide sols may be considered as complex salts of the composition:

$$xAl(OH)_3.yAl/An$$
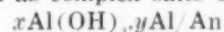
where An is the anion of the salt used in preparing the sol.

The question naturally arises now as to what conditions determine the formation of the insoluble hydroxide and the soluble complex salts of aluminum. In the answer to this question should appear the clue to the cause of the puzzling features of present-day coagulation problems in water supply. Fortunately an abundance of experimental data are available in different fields. They are of sufficient interest and value to discuss at length in this paper. Their practical importance in indicating a solution of our specific problems will be outlined in a later section of this discussion.

In March, 1913, at the Milwaukee meeting of the American Chemical Society Hildebrand[6] presented a paper on "Some Applications of the Hydrogen Electrode in Analysis, Research and Teaching." In this paper Hildebrand demonstrated definitely that aluminum hydroxide is precipitated by sodium hydroxide, while the solution of aluminum sulphate is still strongly acid, the hydrogen ion concentration during the precipitation varying roughly between 10^{-2} and 10^{-5}. He also shows that aluminum hydroxide goes into solution with an excess of alkali, in which the proportion of alkali used corresponds to the formation of $NaAlO_2 - nH_2O$. It is interesting to recall that Hildebrand supported the theory of the solution of aluminum hydroxide as an

acid rather than as a colloid, as claimed by Mahin, Ingraham and Stewart.[1] Hildebrand bases his refutation of the above authors' contention upon the fact that the ultramicroscope fails to show the presence of a colloid in the solutions studied, although the ordinary solutions of aluminum hydroxide produced by dialysis show submicrons very plainly in the ultramicroscope. The conclusions reached by Hildebrand were later substantiated by Bancroft[2], Blum[3], Pauli[4] and others.

The work of Blum[3] is most significant in attempting to clarify some of the results frequently obtained in the application of aluminum sulphate to water. This author has made extensive studies of the reactions of the aluminum compounds with certain bases. His studies are interesting and valuable. From his experiments on the action of sodium hydroxide upon $AlCl_3$ he notes that precipitation of $Al(OH)_3$ begins when p_H is about 3 and is complete before p_H is 7. He finds that for the transition state from p_H 7 to p_H 10.5 a dissolving of aluminum hydroxide in sodium hydroxide is progressively in action, until at the latter point the solution is almost entirely clear. The constitution of the compound contained in the solution at this latter point is indicated by Blum, but the details of this particular subject need not concern us at this time.
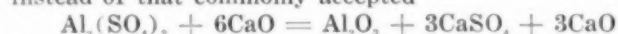
The results of Blum's experiments appear to indicate the existence of definite aluminates of the formulas $NaAlO_2$ and $KAlO_2$ (or multiples thereof) in solutions obtained by the action of alkalis upon aluminum hydroxide. More importantly for the particular subject with which we are now concerned, the experiments demonstrate beautifully that the amount of $Al(OH)_3$ held in a given alkaline solution is *a function of the alkalinity of the solution.* This conclusion cannot be too greatly

FIG. 1. EFFECTS OF H ION CONC. ON SOLUBILITY OF $Al(OH)_3$ (AFTER BLUM)

stressed, since it appears to the writers of this paper to be the basis of a new and better understanding of the whole mechanism of alum coagulation.

The obvious resultant of the above tests is stated in brief by Blum:[3]

"In the case of amphoteric hydroxides, such as $Al(OH)_3$, it is obvious that an excess of the base is to be avoided and it therefore becomes desirable *to select that degree of alkalinity which will insure most nearly complete precipitation and at the same time avoid resolution of the precipitate.*" (The italics are ours.)

In Table I are shown certain data adapted from one of Blum's publications which show quantitatively that the precipitation of aluminum hydroxide by ammonium hydroxide is complete when the p_H of the solution is

between 6.5 and 7.5. What is this point of optimum precipitation in our different water supplies? Have we ever paid any attention to it? We must expect certainly that there are numerous points in coagulation in which re-solution of $Al(OH)_3$ is always in operation. The occurrence of aluminum compounds in filter effluents should be as common as it is now considered rare. Chance, and not mischance, in the past seems to account for its failure to appear.

Further important experimental work on the reactions and constitution of aluminum compounds may be found in the studies by Heyrovsky[9] on the electro-affinity of aluminum, by Michaelis,[10] and on the production and chemistry of satin whites by Cobenzl.[11] The latter adduces reasons for his belief that the reaction of $Al_2(SO_4)_3$ with $Ca(OH)_2$ is as follows:

$$Al_2(SO_4)_3 + 6Ca(OH)_2 = Al_2Ca_3O_6 + 3CaSO_4 . 2H_2O$$

instead of that commonly accepted

$$Al_2(SO_4)_3 + 6CaO = Al_2O_3 + 3CaSO_4 + 3CaO$$

It is interesting to note that Cobenzl suggests that

TABLE I (ADAPTED FROM BLUM)

Precipitation of Al (OH)₃ by NH₄OH at Various Hydrogen Ion Concentrations

Exp. No.	Approximate p_H	NH₄Cl Added g.	Al₂O₃ in Filtrate g.	Remarks
1	6.0	5	0.0010	
2	6.0	5	0.0012	
3	6.5	0	Appreciable	Coagulated poorly
4	6.5	5	0.0001	
5	6.5	5	0.0000	
6	7.5	0	0.0000	
7	7.5	5	0.0000	
8	7.5	5	0.0002	Macerated paper used
9	9.0	0	0.0004	
10	9.0	5	0.0004	

NOTE.—Table I shows that considerable aluminum hydroxide remains unprecipitated at p_H values, varying much from 6.5 to 7.5, as shown by filtrate readings in experiments 1, 2, 3, 8, 9, 10.

calcium aluminate, when formed, is in a colloidal state, and *the particle size may be regulated by the degree of alkalinity of the solution.* May we not find it necessary to search for such complex configurations in our water supply reactions before scientific control is possible?

By way of digression, it is well to call attention at this point to the difference between "precipitation" and "sedimentation" concepts. It is possible to conceive that the points of optimum precipitation and of sedimentation need not coincide. As a matter of fact, there is considerable evidence to suggest that these points rarely coincide. Blum,[3] for example, defines "precipitation" as the chemical formation of $Al(OH)_3$. "This compound (especially in the absence of salts) may not actually coagulate or form a visible precipitate until from one-third to one-half of the alkali required for complete precipitation has been added. The point at which a visible precipitate occurred in the different experiments was found to be very variable." Likewise, Mukhopadhyaya,[12] working on the coagulation of arsenious sulphide sol by electrolytes, finds that settling or sedimentation plays an extremely small part in the coagulation of colloidal arsenious sulphide.

The subject of the effect of the hydrogen ion concentration upon the physical state of such amphoteric colloids as $Al(OH)_3$ should not be left without making somewhat complete reference to the great amount of excellent work performed upon organic compounds of similar structure by Loeb.[4] We can find no better method of clarifying the concepts we have attempted to present in this paper than by quoting at length from one of Loeb's papers dealing with analogies between solutions of gelatine and aluminum salts.

"Gelatine is an amphoteric electrolyte which when the hydrogen ion concentration of its solution exceeds the critical value $2 \times 10^{-5} N$ forms only salts of the type of gelatine chloride, gelatine sulphate, etc., while when its hydrogen ion concentration falls below this value it can form only salts of the form of metal gelatinates—e.g., Na gelatinate, Ca gelatinate, and so on. At the critical hydrogen ion concentration $2 \times 10^{-5} N$—the isoelectric point for gelatine—it can exist only in the form of pure —i.e., non-ionogenic—gelatine. In this condition gelatine is practically insoluble, practically non-ionized, and is practically incapable of producing any osmotic pressure. Both types of gelatine salts, metal gelatinates as well as gelatine chloride, etc., are very soluble, are strongly ionized, and are capable of producing osmotic pressure. The writer's experiments, which are not yet all published, have shown that for each given hydrogen ion concentration there exists a definite equilibrium between non-ionogenic gelatine, gelatine salts and free acid. If we have 1 per cent solutions of isoelectric gelatine, the ionized or salt portion of the gelatine is practically zero. When we add increasing quantities of an acid—e.g., HCl—an increasing portion of the gelatine is transformed into gelatine chloride, while the portion of non-ionogenic gelatine is correspondingly diminished.

The relative proportion of gelatine salt and non-ionogenic gelatine depends therefore upon the hydrogen ion cencentration of the solution and increases in a characteristic way with this concentration. This hydrogen ion concentration of the solution is, of course, not identical with the concentration of the acid added to the solution, since part of this acid is in combination with the gelatine forming the gelatine salt. Since practically only that fraction of the 1 per cent gelatine solution which is transformed into a gelatine salt produces an osmotic pressure, it is obvious that the osmotic pressure of a 1 per cent solution of gelatine must change in a definite way with the hydrogen ion concentration of the solution. If we use different acids we find that different quantities of acid are required to bring a 1 per cent gelatine solution to the same p_H.

FIG. 2.

Chemical influence of H Ion concentration (after Loeb)*

"When the hydrogen ion concentration is below the critical value 2×10^{-5} (or to use Sörensen's logarithmic symbol, when $p_H < 4.7$) a part of the non-ionogenic gelatine is transformed into metal gelatinate, and this part is the greater the more the hydrogen ion concentration falls below 2×10^{-5}. This is again a definite equilibrium between hydrogen ion concentration, gelatine salt and non-ionogenic gelatine.
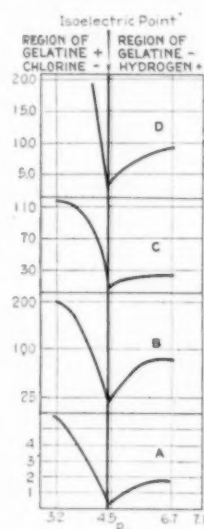
---

*"Amphoteric Colloids," by Jacques Loeb, *Journal of General Physiology*, No. 1, Sept. 20, 1918.

Curves of the conductivity (*A*), osmotic pressure (*B*), swelling (*C*), and alcohol number (*D*) of gelatine previously treated with various concentrations of HCl.

In the region of the isoelectric point ($p_H = 4.7$) all the curves have a minimum. On the left of this point gelatine exists in the form of gelatine chloride (with high ionization), the curves rising more rapidly than on the right of the isoelectric point where the gelatine exists in the form of common gelatine which dissociates as a very weak acid.

Ordinates in curves
  A—Conductivity 10,000 ohms.
  B—Osmotic pressure
  C—Total swelling
  D—Alcohol number

"It is perhaps not without interest that the behavior of gelatine is paralleled by the behavior of amphoteric electrolytes of a crystalloid character—e.g., aluminum salts. Thus aluminum chloride exists only when the hydrogen ion concentration exceeds a certain critical value which seems to lie near that of the point of neutrality. When the solution becomes alkaline, metal aluminates are formed. Na aluminate as well as AlCl₃ is very soluble. At the isoelectric point neither salt can exist and the insoluble Al(OH)₃ is formed. The insoluble Al(OH)₃ has no osmotic pressure (or does not attract water) while solutions of both AlCl₃ as well as NaAlO₂ attract water powerfully. In the presence of AlCl₃ water molecules are apparently negatively electrified and in the presence of NaAlO₂ water shows positive electrification. The turning point for the sense of migration of water molecules seems to lie near or at the isoelectric point of aluminum—namely, p_H about 7.0. It would be very important if we could measure the permanent osmotic pressure of aluminum salts in collodion bags, but this is impossible since aluminum salts, with the exception of the insoluble Al(OH)₃, diffuse through collodion membranes. It is, however, possible to determine the influence of different aluminum salts upon the rate of diffusion of water through a collodion membrane and it is found that this influence obeys the two rules."

Material of a similar nature to the above, although by no means as extensive, has been accumulated by Patten and Johnson,[12] Eckweiller, Noyes and Falk,[13a] and Coulter.[13b] Their results are confirmatory of those already presented.

SIGNIFICANCE OF PRESENT DISCUSSION IN REFERENCE TO PROBLEM OF ALUM COAGULATION IN WATER SUPPLIES

A survey of the facts and theories collected in the preceding portions of this paper has led the writers to formulate a hypothesis regarding the action of aluminum sulphate in water supplies which may properly paraphrase Loeb's conclusions as to proteins. The important features of this hypothesis are as follows:

Aluminum compounds may exist in three states, defined by their hydrogen ion concentration—namely, (*a*) as non-ionogenic or isoelectric Al(OH)₃, (*b*) metal aluminate (e.g., Na or Ca aluminate) and (*c*) alumino-acid salts (e.g., aluminum chloride, aluminum sulphate, etc.). Thus, in practically every water treated with alum, at any point other than the isoelectric point (which has not yet been determined for varying waters), an equilibrium may exist between hydrogen ions, metal aluminates and non-ionogenic or isoelectric Al(OH)₃. (If the p_H were lower than the isoelectric the Al ion would replace the aluminate. In water practice, however, such cases would be rare.) It is reasonable to suppose that just as often as not the p_H of a water is not correct to permit the complete formation of only Al(OH)₃. For this reason the occurrence of other aluminum compounds should not surprise one in filter effluents, for such compounds are soluble and need not be removed by the sand.

Some waterworks investigators have recognized the possibility of formation of aluminum compounds other than the insoluble hydroxide. In most instances, however, these possibilities have been ascribed both to insufficient alkalinity and to peptization. (Stein,[14] Whipple.[15]) In this manner advantage has been taken of both the theories of peptization and of chemical combination. It appears from the preceding material that the

latter explanation alone may suffice if we do not neglect the important factor of the hydrogen ion concentration of the medium with which we are at work. At this point also it is important to suggest that *not only low alkalinity may be fraught with danger but too high hydroxyl ion concentration may not be so desirable* for proper and successful coagulation and for the complete elimination of soluble aluminum compounds. It seems, as a preliminary theory, that as one departs from the point or area of favorable hydrogen ion concentration in coagulation processes, one passes, in either alkaline or acid direction, into fields of re-solution of aluminum hydroxide. This conception, it is clear, is independent of the causes of such re-solution. It is important, therefore, to keep in mind the ever-present possibility of missing the favorable threshold area of coagulation and passing into the unfavorable dissolution areas. This interpretation of the action of aluminum sulphate is widely different from that hitherto accepted, in which the presence of delimited areas of effective flock formation was but little emphasized.

Does the literature of water purification disclose any data in confirmation of the above hypothesis of equilibrium conditions of alum reactions? It should be difficult to obtain such material, since it is only recently that

TABLE II (ADAPTED FROM MORISON)

Volumetric Estimation of Alum in "Solution" in Waters Treated With Various Doses of Aluminum Sulphate

Description of Sample	Approx. Parts per Million Aluminum Salts in Supernatant Water
Raw water + 25 p.p.m. alum. 1 liter evaporated for experiment	1.47
Raw water + 40 p.p.m. as above	1.47
Raw water + 33.4 p.p.m. as above*	0.00
Raw water + 15.0 p.p.m. as above	0.90
Raw water + 40.0 p.p.m. as above	1.75
Raw water + 25 p.p.m. as above	1.47

* Also optimum clarification dose.

determinations of hydrogen ion concentration have been made in water. Hitherto only potential alkalinity and acidity have been determined, because of current methods of titration, while actual alkalinity or p_H values have remained unknown. It is these latter conditions which are usually operative in conditioning our water supply reactions.

ZONES OF COAGULATION

Fortunately we have available an excellent series of experiments in water which does much to substantiate at least some of the possibilities of the suggestions outlined above. It is interesting to find that the author of these experiments, in the distant land of India, did not completely recognize the significance of the data which he reports. In April, 1916, Captain J. Morison[16] of the Indian Medical Service reported upon a series of studies of the clarification of the water supply of Poona by means of alum. The results he obtained may be well interpreted in the light of the theoretical considerations previously presented. Morison's first experiments were made by adding increasing quantities of aluminum sulphate to the turbid water to be studied. He found that the clarification of the water with these different doses exhibited the familiar "zone phenomenon"—that is, "by increasing the dose of alum up to a certain point the clarification improves up to an optimum point where the settlement is excellent; any alum in excess of the optimum point again results in incomplete settlement. Increasing the doses of alum now gives less and less settlement, until a point is reached where the settlement

is no better than that of the untreated water. Further increments of alum produce settlement which finally becomes complete. The improvement, however, is not uniformly continuous. It is broken by waves of which as many as three have been noted." (Fig. 3.)

MORISON'S COLOR TEST

Morison,[16] in addition, makes the important notation that "using now pure hæmatoxylin (Grübler) in a 1 in 1,000 watery solution . . . it was found that a red color was given by the natural water and by the water completely clarified by a dose of alum just sufficient to clear it. If this dose were not attained the water was turbid and gave a lavender or purple color with hæmatoxylin. If the dose were exceeded the clear solution gave either a reddish color which was rapidly decolorized, or a permanent bluish lavender; the latter color appearing when the dose of alum approximated or exceeded 2.2 times the alkalinity. This seemed a curious result. The hæmatoxylin, used to detect the presence of alum, showed that the alum was completely pre-

FIG. 3. CLARIFYING EFFECTS OF ALUM (AFTER MORISON)*

cipitated at a point corresponding to half the weight of alum necessary to react completely with the alkalinity of the water, and that both below and above this point, *in spite of there being in each case an excess of available alkali, there still remained some alum in solution.*" (Present authors' italics.)

Morison then concludes: "In the above experiments where the aluminum sulphate was present in quantities in which it ought to have been completely precipitated by the alkalinity of the water, certain of the aluminum hydrate remained in the supernatant fluid except when the optimum dose of alum was used." With this conclusion in mind, Morison then determined quantitatively the amount of alum present in such supernatant liquors and found that alum could always be detected when the doses were below the optimum point. At the optimum dose the alum, if present at all, was in minute quantities. Morison's figures are given in Table II. It is interesting to recall also that Morison found residual alum present in slow sand filter effluents in Poona, where alum-treated waters were being applied to slow

*"The Dose of Alum for the Clarification of Water by Precipitation," by Captain J. Morison, *Indian Jour. Med. Research,* vol. 3, No. 4, April, 1916.

sand beds. The results were not surprising. The converse of this has been observed by one of us, when on one occasion the alum application was eliminated completely from a mechanical filter for five consecutive days. The effluent nevertheless continued to give the alumina reaction with little or no reduction during the whole of this time.

Of even greater significance in connection with the present subject is the fact that Morison demonstrated that the hæmatoxylin test reacted with hard waters (356 p.p.m.) in a manner very similar to that described for the soft waters (25 to 50 p.p.m.). "Below the zone of settlement, hæmatoxylin gave a gradation of shades of lavender; at the optimum point a red color was produced; immediately above this point the hæmatoxylin was decolorized and, when the dose exceeded 610 p.p.m. (alum) the lavender color returned."[16]

IMPORTANCE OF p_H

A close study of Morison's curves and figures leads one at once to the conclusion that the phenomena he noted were entirely due to changes in hydrogen ion concentration, similar to those outlined in the earlier portions of this paper. The similarity between Morison's curves and those recently presented by Smith[17] is so striking as to lend further emphasis to the controlling importance of p_H in determining coagulation phenomena. Morison[16] was groping for this explanation when he suggested: "It would seem as if the precipitation of the colloids were not so much due to the neutralizing of the charge on one sol by that of another sol or by an electrolyte as to a certain balancing of the acid and basic ions in the solvent, which, when balanced, and possibly by a catalytic action, bring about the coagulation and the precipitation of the colloids." It is also of great interest to recall that not long after this statement Longley,[18] in discussing the nature of color in water, says: "The removal of color by means of aluminum sulphate is influenced by the amount of alkalinity in the water. For a given water there is an alkalinity comparatively low and not many points above the neutral point where the coagulation seems to be best." Does not the work of Loeb, Blum, Morison and others supply us with the quantitative evidence for the general truth of these speculations? Although the present writers are unwilling as yet to subscribe fully to Morison's statement that the optimum dose, the so-called isoelectric point, has been shown in these experiments to be independent of the amount or the nature of the colloid present, yet there is sufficient accuracy of statement therein to warrant a complete change of viewpoint regarding coagulation processes. It will probably be found that the relationships are much more complex, as has been indicated by the work of Smith[17] and of Raju.[19]

In the waterworks field Morison[16] has supplied sufficient evidence of the probable existence of a point or zone of most effective coagulation. In the case of the water with which he was working this point coincided with the point of most satisfactory sedimentation. This coincidence, we believe, was largely a matter of chance, for it is our feeling that the zone of complete coagulation is determined by p_H conditions, while that of sedimentation will probably be dependent upon many other factors. Some slight experimental evidence for this belief is given below. Much more work remains to be done, however, before any real conclusions upon any portion of this interesting subject are to appear.

If the assumptions given above are in any way warranted, we should be able to test their accuracy in the following manner: Theoretically the isoelectric point for Al(OH)$_3$ should be in the neighborhood of p_H 7.0. If we are experimenting, therefore, with a water having a p_H value of 8.0 to 8.6, we should be able to obtain better precipitation of Al(OH)$_3$ if we *acidify* such a water to bring it to a value nearer p_H 7.0. The heroic treatment of acidifying a water to improve coagulation is, of course, contrary to most canons of water purification. Let us see, however, what such treatment calls forth. The data presented are very meager, but they are at the same time interesting. The preliminary experiments are described below (experiments performed by Hannan):

PRELIMINARY EXPERIMENTS—ACIDIFICATION OF WATER

Dec. 15, 1920—Water used in this experiment obtained from slow sand filter effluent, untreated with alum, alkalinity (titratable) in the neighborhood of 90 p.p.m., p_H usually varies between 8.0 and 8.6.

Two samples of 1 liter each were taken of slow sand filtered water; added to each alum at rate of "1 grain per imperial gallon," the rate used in the mechanical filtration plant. To one of the above samples was added 0.8 c.c. normal sulphuric acid. At first the addition of acid had possibly a slightly clarifying effect, but after one hour had elapsed the acid-treated water was distinctly the more opaque. It preserved its lead in this respect up to 2½ hours, when 50 c.c. of each sample was filtered through a single thickness of Whatman No. 1 paper. On adding a drop of hæmatoxylin to each, the acid-treated was brown (probably with a little less acid it would have been the usual rose tint) at first, changing to a clear yellow with one or two drops of N/6 acetic acid. The other showed the usual alumina blue changing to brown with acetic acid; it also filtered more slowly. The alkalinity of the water was somewhat more than half used up between alum and acid. One could probably work with less acid. The required p_H seemed to be around 7.3. It is easy to see why this fact has escaped observation for so long a time. We have always been told that deficiency of alkalinity is the thing to be avoided. No one would be likely to try adding acid.

In the above samples, after standing twenty-four hours in tall cylinders with atmospheric exchange through cotton wool plugs, the acid-alum sample had not begun to settle, while the alum-only had flocked and settled. On filtration through single filter paper the acid alum was still quite alumina-free, while the other showed the usual blue with hæmatoxylin. Owing to loss of carbonic acid the p_H had moved up somewhat. The waters were transferred to glass-stoppered bottles. After forty-eight hours both samples had settled clear. Acid-alum sample still quite alumina-free, while the other as usual showed the blue.

Whether acid or alum is added, it is clear that the carbonic acid liberated determines the p_H. An essentially unstable system is thereby established. It is not surprising, therefore, that in the past contradictory results have been obtained, especially when the attempt is made to correlate with the original alkalinity and the alum dosage. The reader may gain a considerable light on this subject of carbonic acid-p_H system by reference to the work of Johnston,[20] Johnston and Williamson,[21] McClendon,[22] Massink,[23] Heymann,[24] Greenfield and Baker,[25] and Ross and Bagchi[26].

Dec. 27, 1920—An experiment was tried with the effluent of the mechanical filtration plant, which had,

of course, previously been coagulated as part of the usual system of purification. This test was naturally more severe than that described above. The sample was acidified and was left over night in a closed bottle. On the following morning it was filtered through paper. No reaction for Al was obtained in the filtrate. The experiment was not conclusive, for the check sample without acid, when filtered, showed a decidedly less pronounced reaction than usual, although by no means alumina-free.

Jan. 6, 1921—For the sake of brevity, we shall refer to the samples described on Dec. 15, 1920, as: *A.* Slow sand water—alum treated—acidified. *B.* Slow sand water—alum treated—not acidified. On Jan. 6 portions of these waters were again withdrawn. Filtration of the two samples showed the presence of alumina in both, but less in *A* than in *B.* On testing, *A* was found to have become alkaline. This would indicate that the p_H had risen again well above the isoelectric point, and therefore the alumina could not be filtered off, since it had gone into solution once more.

The flock in *A* was more compact and granular and had a faint brown tinge. The flock in *B* was slimy looking and with very indefinite boundaries. The supernatant water in *A* had no observable haze, while that in *B* had a trace of faint haziness (such as is often observed in mechanical filter effluents). The flock in *B* had no trace of brown tinge. The filtration of *A*, as before, was much more rapid than that of *B*.

Jan. 7, 1921—A preliminary series of experiments was carried out in order to shed some light upon the possibility of side reactions in use of alum in water.

TABLE III. POSSIBLE SIDE REACTIONS IN ALUM TREATMENT OF WATER

	Slow Sand Effluent				Rapid Sand Effluent— Each Contained ½ g.p.g. Alum			
Sample Number	A	B	C	D	A	B	C	D
Amount water used, c.c.	250	250	250	250	250	250	250	250
Acid added (1 c.c. conc. HCl)	Yes	Yes	No	No	Yes	Yes	No	No
BaCl₂ added (1 c.c. 10%)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Degree of precipitation	3	3	1	1	4	4	2	2
1—Minimum; 4—Maximum								

In each of four clean 500-c.c. bottles was placed 250 c.c. slow sand effluent; in each of four more similar bottles, 250 c.c. rapid sand effluent already treated at rate of 0.5 grain per imperial gallon. These various samples were treated as shown in Table III. The following tentative hypotheses appear:

(*a*) The sulphate in the slow sand water (known, it may be observed, to contain alumina, in a non-reacting form) is "masked" to a marked extent at the natural p_H.

(*b*) Of the added sulphate ions derived from the alum, a notable proportion is masked at the natural p_H.

(*c*) This effect would be explained if we assume that in the presence of OH-ion non-ionized calcium aluminosulphate is formed. This is known to be unstable in presence of H-ion.

Jan. 24, 1921—In each of six clean glass-stoppered bottles of 1 liter capacity, 1 liter of recently filtered slow sand water was added. Of these, A1, A2, received each 0.6 c.c. normal sulphuric acid. B1, B2, received 0.4 c.c. acid. C1, C2, received no acid. One grain per imperial gallon of alum added to each of the above six samples. Allowed to stand two hours after once thoroughly shaken. No difference in appearance of the six.

From A1, B1, C1, respectively, two successive portions of 50 c.c. were withdrawn and filtered through single thickness Whatman No. 1 paper. Tested for alumina in these six portions with one drop hæmatoxylin, fol-

lowed after a short interval by two or more drops N/6 acetic acid.

Results—A1, both portions alike; brownish shade before acetic acid, clear yellow after; no trace of alumina. B1, both portions alike; tint before acid hard to describe; there was, however, a faint trace of blue; after acid a clear yellow with just the faintest tinge of brown, which would probably escape detection without close comparison; a trace of alumina, certainly under 0.2 p.p.m. C1, both portions alike; blue before acid; brown after; heavy trace of alumina (0.3-0.5 p.p.m.).

Jan. 25, 1921—Withdrew a third 50 c.c. from A1, B1, C1, filtered through the same three papers as before, each through its own paper to avoid adsorption effects. Result same as before. In size of flock and rapidity of clearing, descending order was A1, B1, C1. In the undisturbed bottles the same order was observable— A2, B2, C2. These lagged behind their duplicates on account of agitation in the latter. Filtered off about half of what was left of A1, B1, C1, into Erlenmeyers of 600-c.c. size with view to further experiment.

Jan. 26, 1921—A1 filtered and tested practically alumina-free. The water was filtered during the course of the day in small lots at a time. The faintest possible indication was obtained, due in all probability to the prolonged filtration in small lots having shifted the p_H.

Feb. 5, 1921—Unfiltered and filtered A1 tested for alumina. Unfiltered gave strong reaction; filtrate none or negligibly small.

CONCLUSIONS

Theoretical considerations, supported by experimental results obtained in water work and elsewhere, appear to demonstrate fairly completely that the reaction of aluminum sulphate with the natural alkalinity of a water is a complex mobile transformation. The reaction seems to be delicately dependent upon the actual alkalinity of a water, its hydrogen ion concentration, rather than upon its potential alkalinity. The hydrogen ion concentration in turn is regulated to a large degree by carbon dioxide equilibria. Evidence so far accumulated seems to indicate that complete precipitation of Al(OH)₃ takes place at a hydrogen ion concentration somewhere near the neutral point, p_H 7.0, unless disturbing or buffer influences are operative. Outside of this zone of favorable alkalinity re-solution of insoluble flock occurs to a greater or less degree.

It seems clear, from the above considerations, that the appearance of aluminum compounds in filter effluents should not be accepted as due to faulty operation, according to orthodox interpretations, but to failures due to misunderstanding of the reactions involved. This statement is given in the nature of a hypothesis, to be substantiated by further experimental evidence. If the hypothesis is found to be true, the problem of residual alumina, not only in filter effluents, but in all coagulated waters, may be attacked from a new angle.

The writers have studiously avoided any reference to the sanitary, physiological or economic importance of the passage of soluble aluminum compounds through filters. That it has a great practical importance, however, the little data we now have apparently confirm. Owing to the controversial nature of the subject, it appears best to reserve discussion of this phase until more accurate and complete evidence is available.

In the meantime, the writers have presented here a modification of current theory as to alum action. If we are pressed as to its practical importance, we can only

respond with that learned Frenchman Charles Richet, who said, before the Physiological Congress in 1920, in Paris:

"Seek to understand things; their utility will appear later. First of all it is knowledge which matters."

REFERENCES

[1]Mahin, E. G., Ingraham, D. C., and Stewart, O. J., "The Constitution of Aluminates," *J. Am. Chem. Soc.*, vol. 35, No. 1, January, 1913.

[2]Chatterji, N. G., and Dhar, N. R., "Some Observations on Peptization and Precipitation," general discussion before the Faraday Society and the Physical Society of London, Oct. 25, 1920.

[3]Stieglitz, J., "The Elements of Qualitative Chemical Analysis," p. 171, 1911, N. Y.

[4]Loeb, Jacques, "Amphoteric Colloids," *J. General Physiol.*, vol. 1, 1918-19.
  I. Chemical Influence of the Hydrogen Ion Concentration.
  II. Volumetric Analysis of Ion-Protein Compounds: the Significance of the Isoelectric Point for the Purification of Amphoteric Colloids.
  III. Chemical Basis of the Influence of Acid Upon the Physical Properties of Gelatine.
  IV. The Influence of the Valency of Cations Upon the Physical Properties of Gelatine.

Loeb, Jacques, "Electrification of Water and Osmotic Pressure," *J. General Physiol*, vol. 11, No. 1, Sept. 20, 1919.

Loeb, Jacques, "The Proteins and Colloid Chemistry," *Sci.*, N.S., vol. 52, No. 1350, Nov. 12, 1920.

[5]Pauli, Wolfgang, "The General Structure of Colloids," general discussion before the Faraday Society and the Physical Society of London, Oct. 25, 1920.

[6]Goudriaan, F., "Aluminates of Sodium, Equilibria in the System $Na_2O-Al_2O_3-H_2O$," *Proc. K. Akad. Wetensch.*, vol. 23, pp. 129-142, 1920. *J. Soc. Chem. Ind.*, vol. 39, No. 22, p. 747A.

[6b]Weiser, H. B., "Hydrous Oxides. I—Hydrous Ferric Oxide. II—Hydrous Aluminum Oxide." *J. Phys. Chem.*, vol. 42, pp. 277-328, 505-538, 1920.

[6]Hildebrand, Joel H., "Some Applications of the Hydrogen Electrode in Analysis, Research and Teaching," *J. Am. Chem. Soc.*, vol. 35, No. 7, July, 1913.

[7]Bancroft, Wilder D., "Report on Peptization and Precipitation," Second Report on Colloid Chemistry and Its General and Industrial Application, 1918, British Assoc. for the Advancement of Science.

[8]Blum, William, "The Constitution of Aluminates," *J. Am. Chem. Soc.*, vol. 35, No. 10, October, 1913.

[8b]Blum, William, "The Determination of Aluminum as Oxide," Scientific Papers of the Bureau of Standards, No. 286, Aug. 10, 1916.

[8b]Blum, William, "The Determination of Aluminum as Oxide," *J. Am. Chem. Soc.*, vol. 38, No. 7, July, 1916.

[9]Heyrovsky, Jaroslav," "The Acidity and Constitution of Aluminic Acid, Part III," *J. Chem. Soc.*, No. 696, September, 1920.

[9b]Heyrovsky, Jaroslav, "The Electro-Affinity of Aluminum, I—The Ionization and Hydrolysis of Aluminum Chloride, *J. Chem. Soc.*, vol. 117, pp. 11-26, 1920.

[10]Michaelis, L., Theoretical Studies of Dissociation, II," *Chem. Abs.*, vol. 14, No. 21, p. 3178.

[11]Cobenzl. A., "The Production and Chemistry of Satin Whites," *Chem. Abs.* vol. 14, No. 23, p. 3801.

[12]Mukhopadhyaya, Jnanendranath, "Coagulation of Arsenious Sulphide Sol by Electrolytes," *J. Am. Chem. Soc.*, vol. 37, No. 9, September, 1915.

[13]Patten, H. E., and Johnson, A. J., "The Effect of Hydrogen Ion Concentration on the Liquefaction of Gelatine," *J. Biol. Chem.*, vol. 38, 1918, p. 179.

[13]Eckweiller, Herbert; Noyes, Helen Miller; and Falk, K. George, "The Amphoteric Properties of Some Amino-Acids and Peptides," *J. General Physiol.*, vol. 3, No. 3, Jan. 20, 1921.

[13b]Coulter, Calvin B., "The Isoelectric Point of Red Blood Cells and Its Relation to Agglutination," *J. General Physiol.*, vol. 3, No. 3, Jan. 20, 1921.

[14]Stein, Milton F., "Water Purification Plants and Their Operation," J. Wiley & Sons, 1919, 2d edition, p. 157.

[15]Whipple, George C., "Hot Water Troubles," *Proc.* Amer. Water Works Assoc., 1911, p. 267.

[16]Morison, J., "The Dose of Alum for the Clarification of Water by Precipitation," *Indian Journal of Medical Research*, vol. 3, No. 4, April, 1916.

[17]Smith, Otto M., "The Coagulation of Clay Suspensions and Silicic Acid," *J. Am. Chem. Soc.*, vol. 42, No. 3, March, 1920.

[18]Longley, F. F., "Discussion on 'On the Nature of Color in Water' by Thorndike Saville," *Jour.* New England Water Works Association, vol. 31, No. 1.

[19]Raju, V. Govinda, "Dose of Alumino-Ferric for the Clarification of the Turbid River Waters of Bengal," *Indian Journal of Medical Research*, vol. 6, No. 4, April, 1919.

[20]Johnston, John, "The Determination of Carbonic Acid, Combined and Free, in Solution, Particularly in Natural Waters," *J. Am. Chem. Soc.*, vol. 37, No. 5, May, 1916.

[21]Johnston, John, and Williamson, E. D., "The Complete Solubility Curve of Calcium Carbonate," *J. Am. Chem. Soc.*, vol. 37, No. 5, May, 1916.

[22]McClendon, J. F., "Hydrogen Ion Concentration of Sea Water," *J. Biol. Chem.*, vol. 30, 1917, p. 265; vol. 28, 1916, p. 135.

[23]Massink, A., "The Significance of Hydrogen Ion Concentration in Drinking Water and Particularly for the Business of Water Supply," First Report to the Conference on Food Chemistry, Holland, 1920.

[24]Heymann, J. A. "The Significance of Hydrogen Ion Concentration of the Potable Waters of a Waterworks During Its Development," First Report to the Conference on Food Chemistry, Holland, 1920.

[25]Greenfield, R. E. and Baker, G. C., "Relationship of Hydrogen Ion Concentration of Natural Waters to Carbon Dioxide Content," *J. Ind. Eng. Chem.*, vol. 12, No. 10, October, 1920.

[26]Ross, W. C. and Bagchi, K. N., "The Seasonal Variation in the Reaction and Hardness of River Water in India," *Indian Journal of Medical Research*, vol. 6, pp. 423-9, 1919.

Legal Notes

By Wellington Gustin

Plea of Set-Off Good Where Company Sold Product Exclusively Contracted For by Another

The Supreme Court of Appeals of West Virginia recently decided some interesting points raised in the litigation brought by the Cook Pottery Co. against J. H. Parker and others, partners. (104 S. E., 52.)

The action was begun upon promissory notes of defendants, who filed two special pleas of set-off and a notice of recoupment against the pottery company. In each of the pleas defendants pleaded and relied on a contract between them and the company whereby plaintiff was permitted to manufacture a certain product, which was then owned and controlled by defendants, the same to be sold exclusively to the defendants, and to be invoiced to them at a named price, and with the further agreement on part of the plaintiff that it was to add to the aforesaid price the sum of 24c. per thousand to be credited to the account of defendants in reduction of their indebtedness. This agreement was for five years and as long thereafter as either party to it did not violate the provisions thereof, then to be canceled at the option of the party who had not violated the provisions thereof.

Breach of Contract Claimed

In the first special plea the breach of contract claimed and the matter of set-off relied on by defendants was that prior to the action the pottery company had sold directly to other persons large quantities of the goods, and on all these goods defendants claimed royalty of 24c. per thousand, amounting to $7,200.

In the second plea defendants relied on the same breaches of contract, but instead of the royalty or rent of 24c. per thousand on the goods manufactured and sold to others they claimed the right to offset against plaintiff's claim the difference between the contract price at which the goods were to be billed to defendants and the price at which they were actually sold by plaintiff to other persons, amounting to $45,000, the profits realized by plaintiff in excess of the price at which they were to be manufactured, sold and delivered to defendants.

The court points out that the first objection made to both pleas is that the agreements are not alleged to be in writing, because if not in writing plaintiff would have a right to rely on the statute of frauds, requiring a writing. But a contract in writing need not be pleaded as such, for if the other party thereto wishes to avail himself of the defense of the statute of frauds he may urge it as an objection to receiving oral evidence of the agreement on the trial.

Claim for Royalty Not Unliquidated Damages

Again, it was contended that the matters set out in both pleas were not averred to have originated in or as growing out of the contract sued on, and that both amount to claims for unliquidated damages. It was said that an unliquidated claim for damages can not be set off against a liquidated demand, but if a plea of set-off pleads a claim not resting in uncertainty but is sus-

ceptible of accurate calculation as provided by the contract it may properly be filed, and is improperly rejected.

The first plea amounts to a demand for royalty at the rate of 24c. per thousand for the right to manufacture a product the rights to which are owned and controlled by the defendants. True, the quantity manufactured was not stated, but this was unknown, and it was averred that the quantity was sufficient to have aggregated at least the sum of $7,200. The court says under these facts the amount was merely a question of computation, and the claim was no more unliquidated than if it had been for so many barrels of apples, bushels of corn or the quantity of any other commodity. Unliquidated damages are such as the contract furnishes no means of accurate estimation, but rest in the judgment or discretion of the jury. It is not necessary that the price should have been agreed upon when goods are sold. This fact does not render the claim unliquidated in the sense that it cannot be offset against the demand of the other party. This plea of set-off was held to be good in law. (8 Ann. Cases, 736.)

No Right to Profit on Goods Sold

The second plea averred a claim for damages, being the difference between the price at which plaintiff agreed to manufacture and sell the product to the defendants and the price at which the plaintiff itself sold them to others, an amount unascertainable from any facts alleged or known method of calculation. It was claimed that plaintiff manufactured and sold a particular quantity of the goods, but the court said defendant had no right to the profit made by plaintiff on the goods manufactured and sold by it. The measure of defendants' damages is what they could or would have made if the pottery company had kept its contract to make and deliver the goods to them at the stipulated price. But such cannot be made the subject of a plea of set-off against the plaintiff who brings his suit on a separate and distinct demand. The profits which defendants might have made on such goods if plaintiff had fulfilled his contract were too remote and speculative to be the proper subject of set-off. Therefore this plea of set-off was held not good. (51 W. Va., 523.)

Claim of Recoupment a Valid One

Further, the court held that defendants had the right to file and rely on their notice of recoupment. It was argued against this that the contract for sale and commissions had no relationship to the notes sued on, and that contract did not arise out of the same transaction. The notice alleged an agreement with J. H. Parker & Son in February, 1914, to continue a sale arrangement previously existing upon consideration that Parker would not go into bankruptcy, and that the defendant firm would assume and pay the liabilities of both to the plaintiff, and that the debts would be extended for such time as defendants should be able out of half their commissions earned to pay and satisfy the demands of plaintiff, preferring the open account against J. H. Parker, as stated. Part performance of this contract by defendants was averred and repudiation of it by the plaintiff.

Now the original notes of J. H. Parker were not a part of the same contract set out by defendants, but in so far as any part of the notes sued on entered into the new notes given by J. H. Parker & Son at the time the new contract was made, and when they assumed

the prior indebtedness as alleged, they became a part of the new contract providing for their payment by commissions to be earned, and the court said damages and loss of commissions sought to be recouped against plaintiff's demands by reason of the alleged breach of that contract must be regarded as a claim arising out of the same contract as the notes sued on, and the rule of law applies that when the claim of the defendant arises out of the same contract out of which the plaintiff's demand arose the demand of the defendant, though unliquidated, may be recouped against the plaintiff's claim.

Varnish Drying Patent Held Valid

In a suit brought by the Wenborne-Karpen Dryer Co. against the Rockford Bookcase Co. for infringement of a patent, the patent in question (1,186,477, granted to William M. Grosvenor, June 16, 1916) was held valid and infringed by the District Court of the Northern District of Illinois.

The patent covers a "process for drying and hardening siccative coatings," which consists of simultaneously adding heat and moisture to the air surrounding the siccative coatings. It was alleged by the defendant that substantially the same process has been used for years for the purpose of drying lumber. It was found that too rapid drying of the lumber resulted in the outside becoming case-hardened and steam vapor was therefore introduced into the drying chamber to retard the drying of the outside. As to this point, the court held that there was no analogy between drying wood and drying varnish, since the former is merely the physical process of evaporation, while the latter involves chemical action or oxidation. The phenomena are so different in nature that the discovery that the lumber drying was applicable to varnish drying constitutes a real invention, since the process is not only applied in a different art but with a new and different result. Before the appearance of the Grosvenor process, it was the consensus of opinion that moisture was one of the greatest obstacles to the rapid drying of varnish. For many years prior to the introduction of this process, it required from eighteen to forty-eight hours to harden thick varnish, whereas under the new process the same result was reached in from six to eight hours.

The court also held that the patent was not anticipated by an article on "Pigments, Paints and Painting" written by George Terry in 1893 or by the following patents in the prior art: Schultze, No. 519,352; Victorson, No. 507,512; Gathmann, Nos. 763,387 and 763,388.

The general manager of the defendant's factory admitted that the kiln room was equipped with steam radiators, a pet cock in the steam pipe "serving to let live steam into the atmosphere of the kiln" and an electric fan for the purpose of circulating the air. The claim that the thermometer and hygrometer were not consulted as in the patented process was held not to relieve the infringement.

Consumption of Mercury for Clinical Thermometers

The use of mercury in clinical thermometers does not seem to be a large matter, but the Bureau of Standards estimates that between 3,000 and 10,000 lb. of mercury is so used each year. The average clinical thermometer generally contains about 1 g. of mercury. It is on this basis and with the knowledge of the total production of "clinicals" that the estimate has been made.
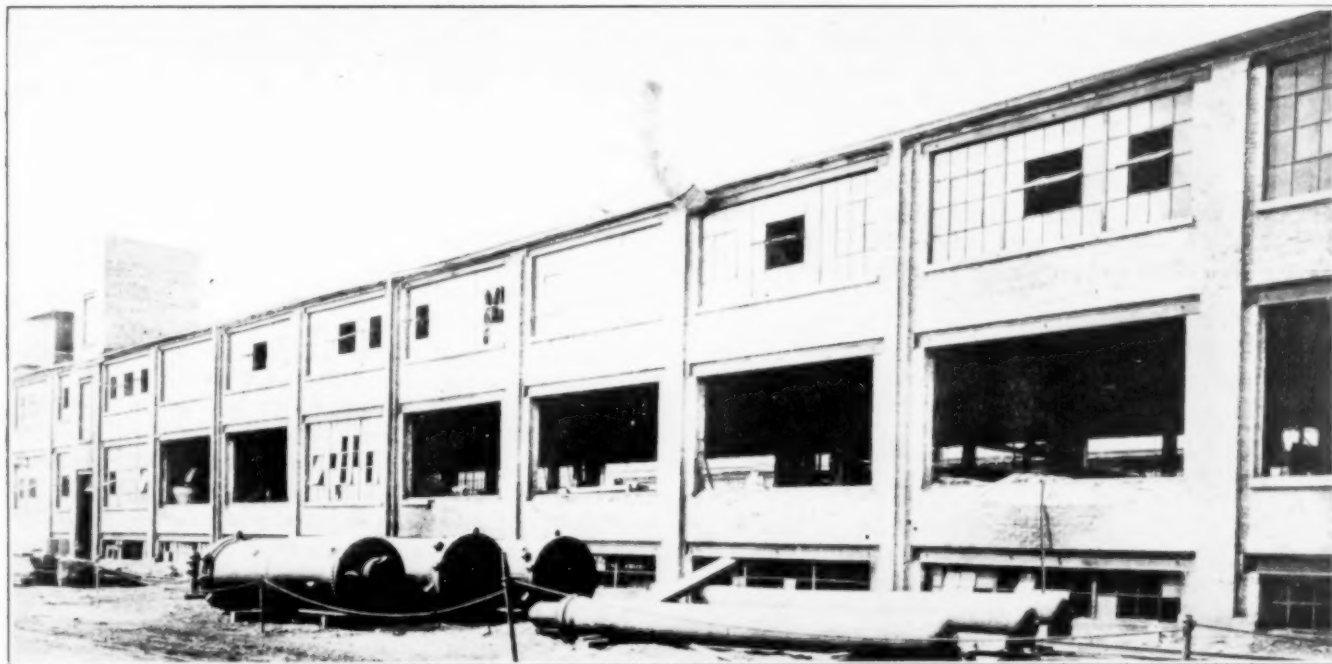
An Explosion of Hard Rubber Dust

Results of Investigation of a Recent Explosion in Reduction of Hard Rubber Scrap Department of a Large Industrial Plant—Recommendations for Prevention and Precautions to Be Taken in Hard Rubber Grinding

BY DAVID J. PRICE* AND HYLTON R. BROWN†

THE fact that practically any kind of combustible dust will explode with violence under favorable conditions when mixed with the proper proportion of air and ignited by a flame or spark has been known for some time. Several recent explosions in factories of the country have shown, however, that some dusts not considered readily combustible are explosive under favorable conditions.[1] An investigation has been made by the Bureau of Chemistry of the U. S. Department of Agriculture of a recent explosion of hard rubber dust in which eight men were killed, one other was injured and property was damaged to the extent of about $25,-000. This article has been prepared to call attention to some of the dangerous practices now followed in the grinding of hard rubber and to suggest methods of minimizing the danger of dust explosion.

REDUCTION OF HARD RUBBER SCRAP

In the case investigated the process followed in the reduction of the scrap rubber was quite similar to the system more or less generally used throughout the country. The scrap rubber is first broken up into pieces about the size of a pea. In some cases this material is heated in large tanks. It is then ground between steam-heated rolls known as refiners or in one of the various types of pulverizers. Sifters are used to separate any coarse particles from the rubber dust, and this coarse material is returned to the grinders. During this process large quantities of very fine dust are produced which tests have shown will explode violently under favorable conditions. Considerable sulphur dioxide gas is frequently produced during rubber grinding and in many cases no provision is made to remove this gas from the building. In such cases the atmosphere of the grinding department becomes a bluish color while grinding is being done.

EQUIPMENT ARRANGEMENT

In the plant where this explosion occurred the grinding department was located in the basement of a two-story brick building. The space allotted to this work was about 60 x 120 ft. The basement was about 10 ft. deep but only about 6 ft. was below the ground level. Windows were provided above the ground line for light and ventilation. Various types of grinding machines were installed with the motors necessary to operate them. These motors were of different makes, but were all of the squirrel-cage induction type. All switches were of the oil-immersed type and the fuses were of the non-arcing type inclosed in covered steel boxes. The electric lights were of the drop-cord type of installation and were not provided with vapor-proof globes or guards. A suction system was provided to remove the dust from the building. The dust was drawn into hoods located over the grinding machines and then into the fan, whence it was blown through

a 24-in. galvanized pipe into a dust house located on the roof of the building. This pipe ran up the outside of the building and had two right-angle turns—one where the pipe came out of a basement window, and the other where it turned to enter the dust house on the roof. The dust house, which was of frame construction with corrugated metal sheathing, consisted simply of an expansion chamber with a number of muslin bags stretched on wooden frames through which
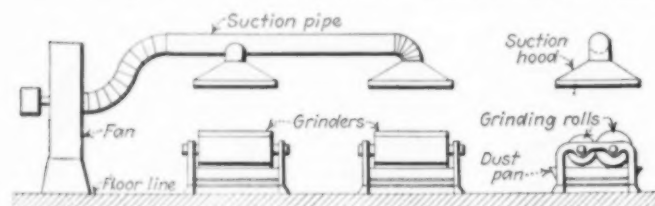
SIDE AND END VIEWS OF GRINDERS AND HOODS

the air escaped, while the dust fell to the floor of the dust house. The dust produced during the grinding was so fine that a large quantity was drawn into the collecting system, and this made it necessary to clean the dust house frequently.

EXTENT OF EXPLOSION

The explosion, which the evidence indicates originated in the basement, occurred about 4:45 a.m. The first explosion was quickly followed by a second one and some families living near the plant report hearing three distinct explosions. As shown in the photographs, the explosion evidently propagated to the first floor of the building, where the windows, doors and one corner of the brick wall were blown out. It also propagated through the suction system to the dust house, which
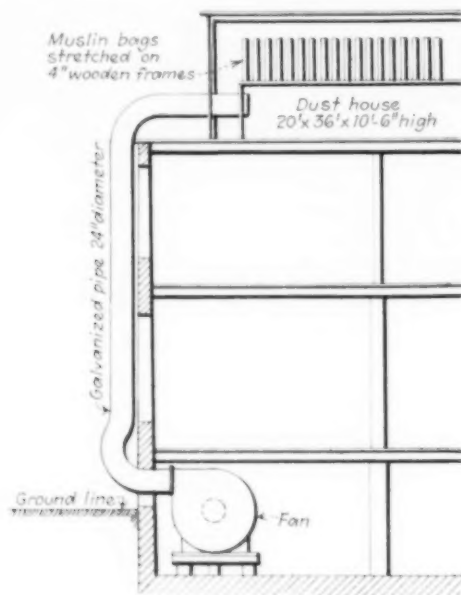
DUST COLLECTING SYSTEM

was completely demolished. The building was quite badly damaged by the explosions and the fire which followed, and windows were broken in other buildings of the plant. The fire department, which was called immediately, soon had the fire extinguished and assisted in rescuing the injured. Ten men were employed in the basement and only two escaped. One of the eight men was killed by the explosion and seven received burns from which they died later at the hospitals to which

they had been taken after the disaster. Several men were employed on the first floor above the section of the basement where the explosion occurred, but they were uninjured.

Two of the workmen were found in the southwest corner of the basement, where they had evidently been blown by the force of the explosion. This fact was taken into consideration during the investigation to determine where the explosion started and what caused it. While the evidence apparently establishes the fact that the explosion started in the basement, it has been impossible to determine definitely what caused the original ignition. Practically all evidence which would have assisted in establishing this point was destroyed by the explosion and fire. The two men who escaped from the basement were unable to give any information regarding the point of origin or cause of the explosion. From the effect of the explosion on various parts of the building and the equipment in the basement it is believed that the explosion started in or near one of the grinding machines.

THEORIES AS TO CAUSE OF EXPLOSION

A number of theories have been advanced as to the cause of the explosion: (1) The dust may have been
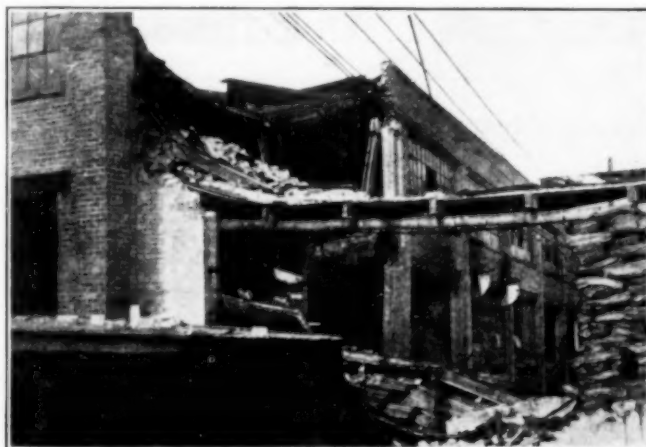
VIEW SHOWING DISRUPTED WALLS

ignited by sparks formed when some foreign material entered the grinding machine with the scrap rubber. It is known that pieces of metal are frequently found in scrap rubber, and explosions in other industries have been caused by sparks formed when metal entered the grinding machine. (2) An electric light may have been broken accidentally and the dust ignited by the hot filament. Experiments have definitely established the fact that explosions can be started in this way.[2] In this explosion the wires and light fixtures were so badly burned or damaged by the explosion and fire that it was impossible to determine whether or not a broken light caused the ignition of the dust. (3) Static electricity often accumulates on moving machinery and unless the machine is properly grounded the charge is built up until it becomes strong enough to break down the air gap and jump to some other machine or a ground. Sparks formed in this way will ignite certain dusts, but in this case no static electricity had ever been noticed on any of the machines. It is therefore considered improbable that a static spark was responsible for the ignition of the dust. (4) A lighted match would ignite the dust. Since in this case eight

[2]*Electrical Review*, vol. 78, No. 5, Jan. 29, 1921, p. 180.

of the workmen were killed and the two others were unable to give any information as to the cause of the explosion, it is impossible to substantiate the theory that a lighted match started the explosion. (5) Explosions have been started by sparks in dust-collecting fans when the blades struck some metallic substance entering the fan or when the blades became loose on the shaft and struck against the fan casing.[3] In the investigation of this explosion special attention was given to the condition of the fan after the explosion. It was found that the side of the fan casing where the suction pipe from the dust hoods entered the eye of the fan was blown completely off. The exhaust pipe from the fan to the dust house was blown apart at both elbows. The dust house on the roof of the building was completely destroyed, as shown in the photograph. It had been cleaned about midnight, or approximately four hours and forty-five minutes before the explosion occurred. It is estimated that at the time of the explosion the house contained about 125 lb. of dust.

ORIGIN OF EXPLOSION

The fact that so much damage was done to the fan and exhaust pipe would indicate that the explosion had built up considerable force by the time it reached this point in the system. It is believed that the explosion originated in or near one of the grinding machines and was caused by foreign material entering the grinder, by a broken electric light, or by a lighted match. The flames propagated throughout the basement, where the employees were severely burned, and extended to the first floor, where the windows and one corner of the wall were blown out. The flames entering the suction hoods flashed through the suction pipe to the fan, where they met their first obstruction and built up the pressure which blew out the weakest side of the casing—the one containing the inlet opening. The flames also propagated through the fan into the exhaust pipe, built up sufficient pressure at each bend to rupture the pipe and continued into the dust house on the roof of the building, where enough dust was present to cause an explosion which completely wrecked the house. It must be remembered that this is only a theory of what happened during the explosion built on the knowledge obtained during investigations of previous explosions in industries where the conditions and some of the installations were similar to those in the hard rubber grinding industry.[4]

RECOMMENDED PRECAUTIONS IN HARD RUBBER GRINDING

This explosion proves very conclusively that grinding hard rubber is a dangerous process and indicates very clearly some of the precautions which should be taken to guard against explosions. In other industries, particularly feed manufacturing, it has been necessary to give special attention to the prevention of explosions in the oat hull grinding department. It is believed that the methods adopted in this industry will be equally effective in preventing damage from dust explosions in grinding hard rubber:

1. The grinding department should be segregated from the remainder of the plant and if possible operated independently of other units.

[3]CHEM. & MET. ENG., vol. 23, No. 19, p. 915.
[4]*Proceedings* of Conference of Men Engaged in Grain Dust Explosion and Fire Prevention Campaign Conducted by U. S. Grain Corporation in Co-operation with Bureau of Chemistry, U. S. Department of Agriculture, July, 1920.

2. The building containing the grinding department should be of heavy framework with light walls and roof so as readily to permit the release of pressure from the building should an explosion occur. Large window area serves this purpose very well and the modern daylight construction is recommended.

3. Good ventilation should be provided and where gases heavier than air are produced during the process the air should be drawn out of the room near the floor and fresh air admitted near the ceiling or roof.

4. Where fine dust is produced during the process an efficient dust-collecting system should be installed. The old-style dust room, where large clouds of dust are in suspension, should be eliminated if possible or

REMAINS OF THE DUST HOUSE

located at a safe distance from the main building. The dust should be collected as near as possible to the point of origin and conveyed through pipes with as few turns as possible to the collector, which should be located outside of the building or vented to the outside air. If sharp turns are necessary in the pipe line inside the building, it is often advisable to provide a vent at the bend leading to the outside air with a cap which will be blown off should any high pressure occur at this point. Drawing explosive dusts through a fan should be avoided if possible. A suction through the collector or an induced-air current is preferable.

5. Special precautions must be taken to see that no metal enters the grinding machines. This is the only way to guard against ignition of dust by sparks struck in the machines. A vent leading directly from the machine to the outside air often assists in preventing a disastrous explosion by providing a direct means of escape for the primary explosion within the machine.

6. In places where clouds of explosive dusts are produced electric lights should be inclosed in vapor-proof globes and properly guarded to prevent accidental breakage. All switches and fuses or electrical equipment in which sparks might be produced should be located in a separate room or at least inclosed in fireproof and dustproof boxes.

7. Rules against smoking and carrying matches in sections of a plant where conditions are favorable for a dust explosion must be rigidly enforced and special attention given to the prevention of hot boxes on machinery operating in dusty atmospheres.

8. Cleanliness is the best general precaution to adopt for the prevention of dust explosions. A disastrous dust explosion cannot occur in a clean plant,

because the flames cannot propagate unless dust is present to be mixed with the air in sufficient quantity. From 0.02 to 0.04 oz. of dust per cu.ft. of air is usually sufficient to form an explosive mixture. The plant should be kept scrupulously clean, especially overhead structures where dust accumulations could be thrown into suspension in the air by a sudden jar or shock.

The increase in the number of industries in which the danger of dust explosion is present makes it imperative to conduct further research and investigational work. The various explosive dusts ignite at different temperatures, and different amounts of the various dusts are required to form explosive mixtures with air. Perhaps some dusts not now considered dangerous will later be found to be explosive under certain conditions. It may be found necessary to design special equipment to reduce the danger of dust explosions in certain industries. The question of dust explosions in flour mills and grain elevators has been studied for several years by the Bureau of Chemistry of the U. S. Department of Agriculture and the results of this work have been published in bulletins which are available for distribution, but no provision has been made to continue these investigations during the present year. Since it is a question of vital importance to the industries of the country, it is hoped that some opportunity will be presented in the near future to resume the study of dust explosions in flour mills and grain elevators and extend the work to other industries where the same hazard exists.

Bureau of Chemistry,
U. S. Department of Agriculture,
Washington, D. C.

Plastic Gypsum Plaster

By Warren E. Emley

A GOOD job of wall plaster is composed of three coats, which are known to the trade as "scratch," "brown" and "finish." The scratch coat is next to the lath, the brown coat in the middle, and the finish coat is applied to the exposed surface to give the plaster a pleasing appearance.

The quality requirements put upon material for the finish coat are peculiar: It must be very plastic in order that it can be spread in a thin layer ($\frac{1}{16}$ in.) over the brown coat, which has set and is partially dry; and it must set in twenty or thirty minutes, in order that the plasterer may finish troweling it without moving his scaffold.

The scratch and brown coats may be made with either plaster of paris ($CaSO_4.\frac{1}{2}H_2O$) and sand or of lime and sand, but the finish coat must consist of both lime and gypsum plaster. The addition of lime has been thought necessary to give the proper degree of plasticity. As the weight of the finish coat is very small in comparison with the weights of the two other coats, the contractor must provide enough for all three coats and a small amount of lime for the finish coat mixture when gypsum plaster is used. It seems impossible to get good results with a ready mixed lime gypsum plaster. The lime must be soaked with water for at least twenty-four hours in order to develop its plasticity, and the gypsum cannot be soaked, because it sets upon the absorption of $1\frac{1}{2}$ mols of water of crystallization. This means that the materials must be prepared separately and mixed just before being used, thereby requiring extra labor and equipment.

The higher plasticity of lime gives superior sand-carrying capacity. If lime and gypsum plaster are selling at about the same price, the fact that lime can carry three parts of sand for scratch or brown coat work, while the latter can carry only two, makes the lime plaster much cheaper. At the same time, the superior plasticity of the lime may reduce the labor cost of application of the plaster considerably below that of the gypsum plaster.

From the above statements it will appear that if a plastic form of gypsum plaster can be made without the use of hydrated lime, the differential in favor of lime, due to its greater sand-carrying capacity, will be overcome. Also it will not be necessary for the gypsum manufacturer to add lime or any other foreign material (except retarder) in the preparation of neat gypsum plaster. These results are greatly to be desired, not only by the gypsum industry, but also by the general public, because they would tend to decrease the cost of an important building material.

Accordingly, work was started on an attempt to make gypsum plaster as plastic as lime. The first successful experiment was completed on Sept. 13, 1920, and since that date sufficient work has been done to make sure of the practicability of the method. The problem may therefore be considered solved, in so far as it can be solved with laboratory equipment.

Degree of Subdivision of the Hemi-Hydrate

The first thought was that plasticity is in some way dependent upon the degree of fineness, and that fine grinding might solve the problem. Fine grinding in itself is not new in the industry, and it would seem strange that any increase of plasticity due to it could have passed unobserved. Investigation has shown, however, that all attempts at fine grinding on a practical scale had been conducted in a buhr or tube mill. It has long been known that the half mol of water of crystallization can be "ground out" of gypsum plaster. When it is reduced in either of the above types of mills, the volume of air passing through the mill carries off the water vapor as fast as it is formed by the frictional heat. If the grinding is sufficient to liberate all of the water, the resultant product is soluble anhydrite. This is a peculiar form of anhydrous calcium sulphate and differs from the mineral anhydrite in its great affinity for water. So great is this affinity that a very short exposure to moist air is sufficient to change it back to the hemi-hydrate. When ground in the usual type of equipment and the frictional heat is not sufficient to liberate the water of crystallization, the size of the grains is not greatly reduced. If the anhydrite is formed, the final product soon absorbs water from the air and the crystals cake into larger aggregates that do not give a plastic plaster.

When calcined gypsum is subjected to grinding under such circumstances that the water is not permitted to escape from the system, an entirely new product results. No satisfactory explanation has yet been evolved, but the fact remains that the product is plastic. Up to a certain limit the degree of plasticity seems to depend upon the duration and speed of grinding.

The plasticimeter described in Bureau of Standards Technologic Paper 169 is not yet adapted to measure the plasticity of unretarded calcined gypsum; the material begins to set before the experiment can be completed. Use has therefore been made of the Carson blotter test, as described in the *Transactions* of the National Lime Manufacturers' Association for 1916.

This has proved quite satisfactory as a means of differentiating between the plasticities of finishing hydrate and masons' hydrate. When tested by this method, this "plastic gypsum" proves to be more plastic than the best lime putty.

BETTER STRENGTH AS WELL AS PLASTICITY

Besides improving the plasticity, the process also causes certain changes in other properties of the material. The increased fineness of the plastic gypsum naturally necessitates the use of more water to bring the paste to a given consistency. Yet, in spite of this excess water, the set material will average about 20 per cent stronger than that made from ordinary calcined gypsum. The process slows down the setting reaction somewhat. The time of set of one sample was changed from twelve to seventeen minutes by this kind of fine grinding. Commercial calcined gypsum usually deteriorates somewhat on storing. It tends to work "lean" and carry less sand. Samples of this plastic gypsum have been exposed to the air for four months without apparent deterioration of their plasticity.

The process has been applied with equal success to calcined gypsums from Nova Scotia, New York and Virginia. It would seem, therefore, that the original quality of the material is of little importance.

GRINDING WORK ABOUT DOUBLED

The laboratory results have been accomplished after calcination by grinding the material in a ball mill constructed so that the water vapor could not escape. Commercial calcined gypsum is always ground during the course of manufacture, either before or after calcination, so that the grinding required to make plastic gypsum does not entail the installation of an extra process. It would seem, however, that the grinding should be done after calcination rather than before to prevent the powder balling up in the mill.

It is probably not essential that a ball mill be used; a buhr mill or tube mill may be satisfactory if there is no loss of water by evaporation during the grinding. It is essential that the product as it leaves the mill shall contain approximately the same quantity of fixed water as commercial calcined gypsum does: 9 parts by weight of water to 136 parts of calcium sulphate, or about 6.2 per cent water.

The duration of grinding required to make plastic gypsum depends upon the kind of equipment used, the fineness and hardness of the material, and the degree of plasticity desired. This problem must be worked out individually by each manufacturer for his particular equipment and material. It is a simple matter to regulate the grinding until the Carson blotter test shows the material to have the desired degree of plasticity. Laboratory experiments indicate that the output will be considerably reduced, perhaps cut in half, if the same equipment is used to make plastic gypsum.

The new product, "plastic gypsum," was demonstrated at the annual meeting of the Gypsum Industries Association on Dec. 15, 1920, but the process of manufacture was not divulged. A patent, covering both the process and the product, has been applied for, and, if granted, will be given to the public for the free use of anyone in the United States. This description of the process is being released at this time in order to give additional protection to the public interest.

Tower Packing Efficiencies

BY E. L. JORGENSEN

WHEN devices prove their usefulness in industry through years of service, they are readily accepted as standard and improvements are retarded until retrenchment becomes a matter of great importance. A careful analysis then often shows the way to improvements surprising in their simplicity and importance.

Opportunities for such improvements seem to exist in several branches of sulphuric acid manufacture. In studying construction costs for a chamber acid plant, it is of interest to learn that Glover and Gay-Lussac towers account for from 25 to 40 per cent of the capital expended, and only 5 to 6 per cent of the cost of the towers is for packing.

Considering that in these towers the packing performs all of the active work, the improvement of such packing seems worthy of careful study. If the effect of such packing can be increased, new towers could be built smaller or present towers could be increased in productiveness by re-packing.

GREAT VARIATION IN TOWER PACKING EFFICIENCY

Investigations conducted for this purpose indicate that the effectiveness of tower packings such as they are today can be improved in some cases as much as 100 times.

The factors that control the effectiveness of tower packing are the area of contact surfaces and the length of time of contact between these surfaces and the gases. The length of time depends on the effective space occupied by the gases. If in a cubic foot of packing space one-half of the volume is dead space occupied by packing and one-half active space occupied by gas, then each cubic foot of gas passing through per second will be exposed to the contact surface for one-half second.

EMPIRICAL CALCULATIONS

The influence of contact surface and of time of contact can be mathematically expressed as follows:

Capacity, $C_1 = 0.3706C$;
$$C = s \times v;$$
s = sq.ft. of contact surface per cu.ft. of packing space;
v = cu.ft. of active space per cu.ft. of packing space.

This formula has been applied to a number of tower packings in use today and to new forms of packing that have suggested themselves as a result of these investigations. The results are given in the accompanying table and the arrangements are illustrated in the figure.

In the table of values for C_1, the factor 0.3706 is based on a well-known packing built as checkerwork of 9-in. straight brick placed 9-in. on centers. This serves to facilitate comparison.

When applying higher mathematics to the problem it is found that with packing made of plane-parallel bodies the maximum of effect is reached when the active space and the dead space, or the space occupied by the packing itself, are the same.

To increase the effect of towers of today without increasing their size or to reduce the size of a new installation it is necessary to resort to thinner shapes.

To facilitate the use of thinner shapes means of equal spacing and of maintaining stability must be provided.
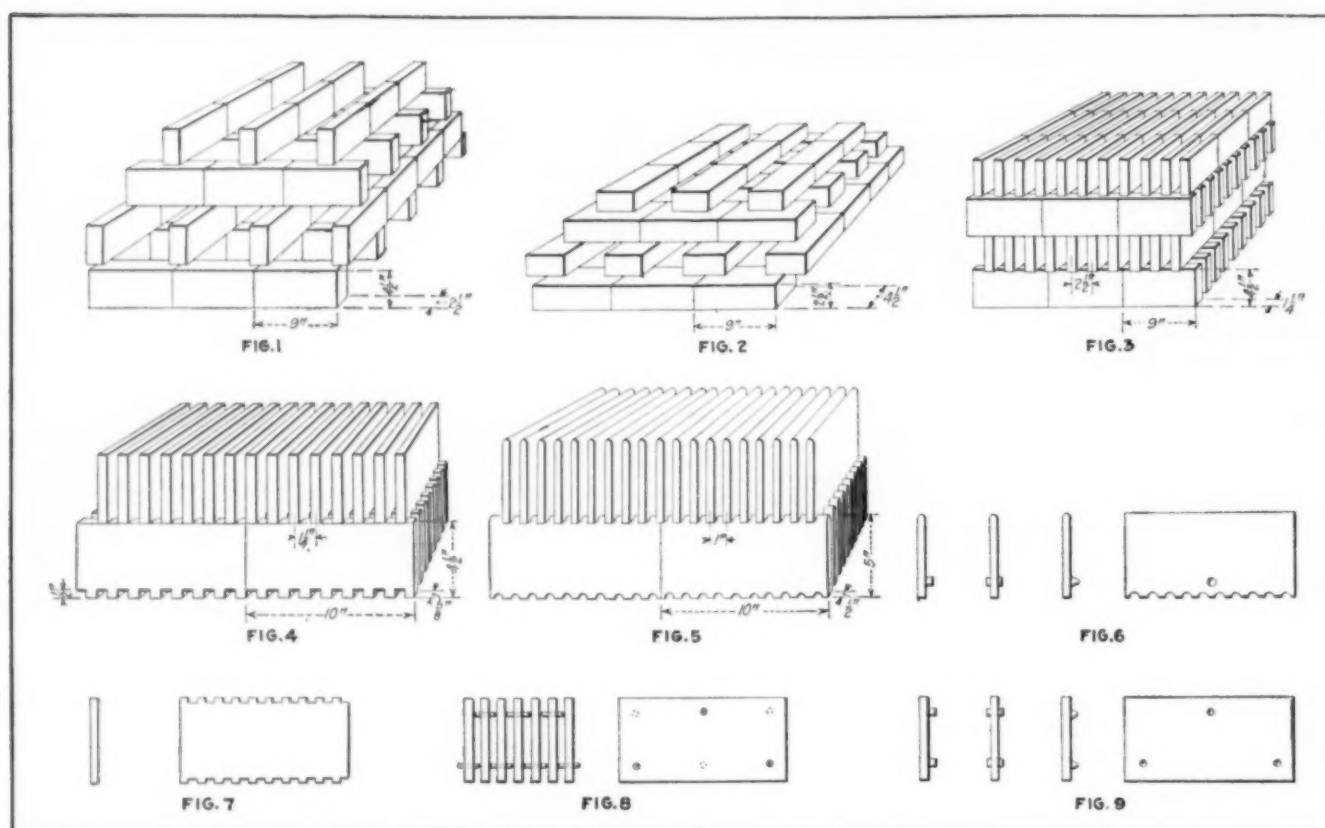
ARRANGEMENT FOR TOWER PACKING

Fig. 1. 9-in. straight brick on edge 9-in. centers. Fig. 2. 9-in. straight brick flat 9-in. centers. Fig. 3. 9-in. split brick 2.5-in. centers. Fig. 4. Brick checkerwork. Fig. 5. ½ x 5 x 10-in. tile. Fig. 6. Detail of tile provided with semi-circular, square, triangular or other type notches at foot and with top edge to correspond to the notches, also with knob for proper spacing. Fig. 7. Detail of tile with notches of any shape at head and foot for proper spacing. Fig. 8. Detail of tile with holes and dowels for proper spacing. Fig. 9. Detail of tile with knobs of any form for proper spacing.

To accomplish this a number of suitable interlocking devices are suggested, as shown in the illustrations.

Lunge in his book on "Sulphuric Acid and Alkali" states that coke-packed towers have only one-twentieth to one-fortieth the capacity of towers packed with so-called Lunge plates. Lunge plates upon mathematical analysis show a capacity of only 41.2 per cent of a packing made from 9-in. straight brick placed 9-in. on

CAPACITY OF TOWER PACKINGS BY MATHEMATICAL ANALYSIS

Fig.	Description of Packing	a	r	C	C_1
1	9-in. straight brick on edge, 9-in. on centers	3.7361	0.7222	2.6982	1.000
2	9-in. straight brick on flat, 9-in. on centers	5.0664	0.5000	2.5332	0.940
None	9-in. straight brick on edge, 4.5-in. on centers	6.650	0.4444	2.9553	1.095
None	9-in. straight brick on edge, 5-in. on centers	6.1333	0.5000	3.0667	1.136
3	9-in. split brick on edge, 2½-in. on centers	10.930	0.5000	5.4650	2.025
4	½-in. tile, 10x4½-in. with notches ¾x2½ in. placed ½ in. on centers	22.650	0.4688	10.617	3.935
5	½-in. tile 10x5-in. semi-circular top and slots ½ in. on centers	25.1274	0.4900	12.312	4.563
None	Spheres 6 in. diameter	8.88	0.26	2.3088	0.86
None	Spheres 5 in. diameter	10.656	0.26	2.7706	1.02
None	Spheres 4 in. diameter	13.320	0.26	3.4622	1.28
None	Spheres 3 in. diameter	17.760	0.26	4.6176	1.771
None	Spheres 2½ in. diameter	21.322	0.26	5.5411	2.054
None	Spheres 2 in. diameter	26.64	0.26	6.9264	2.567
	Lunge plates*	2.2312	0.50	1.1156	0.412
	Niederfuhr Glover tower pkg.†	5.1408	0.5764	2.9632	1.098
	Quartz and coke ‡	......	......	......	0.02–0.04

* See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, pp. 661-2.
† See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, p. 872.
‡ See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, p. 664.

centers, and coke and quartz packing therefore have only 2 to 4 per cent of the capacity of the brick packing.

This brings out a third and even more important factor influencing the effectiveness of tower packings. The flow of gas must be even and equally distributed in all parts of the packing so as to give a perfect balance between contact surfaces and flow of gas.

If the channels or passages for gas are uneven, a rush of gas will go through the larger openings or channels, where the area of contact surfaces is smaller. The descending liquid will be diverted to the locality where the surfaces are largest and the gas passages and the pieces of packing are smallest. Carrying this reasoning to the extreme, the case may arise when all liquid passes through the smallest channels, completely filling them, and all gas through the largest channels, with the result that the effect of the tower is reduced to a minimum. This explains the small amount of work done by towers packed with coke or quartz.

This weakness exists in a number of tower packings in vogue today where gas passages are not of uniform size. A slight disturbance of the balance between flow of gas and contact surfaces is enough to cause great decrease in the effect of the packing.

Attention is invited to the figures given before, showing the high cost of towers and the low cost of packing, and to the figures of the table showing the possible improvements upon today's practice.

Records show the sulphuric acid production of the United States to have been equivalent to about 6,000,000 tons of 50 deg. Bé. acid per year. Taking the cost of the plants to produce this acid to be approximately $120,000,000, the cost of towers for these would be about $40,000,000.

These figures would seem to warrant most careful study and sincerest consideration for more effective packing for new towers as well as for the re-packing of existing installations, in all chemical industries where the contact between gases and liquids is of predominating importance.

150 Nassau St.,
New York City.

The Problem of Reorganization of the Federal Government*

By Herbert C. Hoover

THERE is one problem of the new administration that has received the attention and thought of the organized engineers of America for many years past. This is the problem of the reorganization of the federal government. The inadequacy, the wastefulness and the inefficiency of our federal organization was evident enough under pre-war conditions. These inadequacies, these inefficiencies, these wastes were exhibited to the country during the war at the cost of millions.

Congress has placed the problem in the hands of a very able Congressional joint committee. But if this joint committee succeeds in securing the imminently necessary results it will only be by full insistent support to it by public opinion. Many attempts have been made at reorganization before, but all of them have gone to the same crematory—the interminable differences in opinion among the executive and legislative officials over details.

To any student of federal organization one sweeping and fundamental necessity stands out above all others, and that is that the administrative units of the government must be regrouped so as to give each of the great departments more nearly a single purpose. The hodgepodge of aims in certain administrative branches is scarcely believable when we consider our national pride and skill in organization. Such functions as public domain, public works, assistance to veterans, public health functions, aids to navigation, to industry, to trade, purchasing of major supplies, are each and every one scattered over from four to eight departments, most of which are devoted to some other major purpose.

How to Perfect Economies

Economies can be accomplished from a public point of view by an elimination of the overlap in these different units of administration through unification into groups of similar purpose. The real economy to the nation, however, does not lie here, however great this may be, but it lies in their more effective functioning in their daily relation to the public. The extra cost imposed upon business in general in the determination of the relation of any particular business to the different functions of the government, with the unnecessarily duplicating interferences and demands, is a real charge on national wealth, probably as great in some directions as the actual costs of the administrations themselves.

Of equal importance with economy is to secure effective concentration of government effort into service to the community. No constructive vision or policies can be built around a national service directed by from two to ten Cabinet members, more especially when this particular purpose is a side issue to all of them. No better example of this exists than the deplorable handling of our relations to our veterans.

There are other reasons that render reorganization imperative. The changed economic situation of the world demands that the functions of the government in aid to commerce and industry be given more concentration and wider scope.

The enlarged activities of the government as a result of the war greatly affect certain departments. The

Treasury today as the fiscal office of the government must handle an annual budget of $5,000,000,000 as compared with $1,000,000,000 before the war. Activities of the Army have increased from a budget of $200,000,000 to $400,000,000; activities of the Navy have increased from a budget of $125,000,000 to $425,000,000. Thus the burden and responsibilities for the major purposes of these departments have been enormously increased. I believe it is the consensus of the gentlemen conducting these departments that in the interests of efficiency they should not be called to responsibility for the administration of at least some of the matters not pertinent to their major functions which clutter their departments.

We have also some confusion between executive, advisory and semi-judicial functions. One of the tendencies of government both local and national during the last twenty years has been to add executive functions to commissions and boards created primarily for advisory or regulatory purposes. It requires no argument with our business public that the executive functions cannot rise to high efficiency in the hands of government boards where from the very nature of things each member has a separate responsibility to the public and is primarily engaged in a semi-judicial function.

Furthermore, during the last few years there has been a great growth of independent agencies in the government reporting directly to the President until his office is overburdened almost beyond the point of endurance. The original and sound conception was that the executive functions should be reported up to the President directly through his Cabinet officials. Not only do these outside functions today overburden the President but they render co-ordination with executive departments extremely difficult. It is neither possible nor advisable to place all these outside organizations into the departments, but much could be done to mitigate the situation.

One of the great steps in federal reorganization is the erection of a budget system, with its necessary reorganization of the Congressional committees. There can be no doubt as to the early accomplishment of this great reform, but it will not serve its real purpose until the departments have been reorganized so that they represent a common purpose. Without this Congress will never have before it budgets showing the expenditure of the government in its relation to any particular function.

Trials of the Mariner

I have daily evidence in the Department of Commerce of all these forces. The question of governmental aids to navigation is not by any means one of the principal functions of our government, but it must be a sore trial to the hardy mariner. He must obtain his domestic charts from the Department of Commerce, his foreign charts from the Navy Department and his nautical almanac from the Naval Observatory—and he will in some circumstances get sailing directions from the Army. In a fog he may get radio signals from both the Navy and Commerce, and listen to foghorns and look for lights and buoys provided him by Commerce; if he sinks his life is saved by the Treasury. He will anchor at the direction of the Army, who rely upon the Treasury to enforce their will. His boilers and lifeboats are inspected by the Department of Commerce; his crew is certificated by one bureau in Commerce, signed off in the presence of another and inspected at

sailing by the Treasury and on arrival by the Department of Labor.

It is possible to relate the same sort of story in our governmental relations to industry to our domestic and foreign commerce.

The moral of all this is that economy could be made by placing most of these functions under one head, not only economy to the government but to the mariner. Congress would know what it spends in aid to navigation and the government could develop definite policies in giving proper assistance, and lastly could remove from the hardy mariner's mind his well founded contempt for the government as a business organization.

The economic changes in the world, growing out of the war, and their reflex upon our trade and industry make it vital if we are to maintain our standards of living against increasing ferocity of competition that we shall concentrate and enlarge our national effort in the aid, protection, stimulation and perfection of our industrial and commercial life. There can be no real Department of Commerce or commercial policies to these broad purposes so long as the instrumentalities of the government bearing on these questions lie in half a dozen departments.

We want no paternalism in government. We do need in government aids to business in a collective sense. In a department we do not want either to engage in business or to regulate business. We need a department that can give prompt and accurate diagnosis from both a foreign and domestic point of view of economic events, of economic tendencies; of economic ills; that can promptly and accurately survey economic opportunity, economic discrimination and opposition; that can give scientific advice and assistance and stability to industry in furnishing it with prompt and accurate data upon production, supplies and consumption; that can co-operate with it in finding standards and simplifications; that can by broad study promote national conservation in industry and the elimination of waste; that can study and ventilate the commercial side of our power possibilities; that can study and advise national policies in development of rail, water and overseas transportation; that, in fact, covers, so far as government functions can cover, the broad commercial problems of trade, industry and transportation.

This can be accomplished more by co-ordination of existing governmental facilities than by increased expenditures.

The Magnesite Industry in 1920

THE production of magnesite in the United States in 1920 increased 94 per cent in quantity over that of 1919. The entire output was made by two states, California and Washington. California mined 63 per cent more magnesite in 1920 than in 1919 and more than eight times as much as it mined seven years ago. Washington increased its production 109 per cent over that of the preceding year, making by far the largest output it has yet made.

According to the United States Geological Survey the total production of magnesite in the United States in 1920 was 303,767 short tons, which was valued at approximately $2,748,150. The following table shows the production by states:

CRUDE MAGNESITE PRODUCED AND SOLD OR TREATED IN THE UNITED STATES, 1913-1920

| | California | | Washington | |
Year	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
1913	9,362	$77,056	......	....
1914	11,293	124,223	......	....
1915	30,499	274,491	......	....
1916	154,259	1,388,331	715	$5,362
1917	211,663	2,116,630	105,175	783,188
1918	84,077	761,811	147,528	1,050,790
1919	50,020	504,973	106,206	743,442
1920	81,782	1,083,262	221,985	1,664,888

Most of the output of California was calcined and used as plastic material, only a small part being natural ferromagnesite, used as a refractory lining of steel furnaces on the Pacific Coast. On the other hand, practically all the magnesite mined in Washington was dead-burned into synthetic ferromagnesite and used as a refractory lining of furnaces and smelters.

The largest producers in California were the Tulare Mining Co. and the Sierra Magnesite Co., at Porterville; the White Rock mine, operated by Frank R. Sweasy, in Napa County, and the property of the Western Materials Development Co. on Red Mountain, operated by C. S. Maltby.

The Northwest Magnesite Co., of Chewelah, Wash., was the largest producer in the United States. It shipped in 1920 more than 90,000 tons of dead-burned ferromagnesite, most of which was sent to steel companies and manufacturers of refractory products east of the Mississippi. The American Mineral Production Co., of Valley, Wash., sold its output crude to the Northwest Magnesite Co., whose quarries are near by. The Western Materials Co. operated the Double Eagle magnesite mine, near Valley, and shipped the calcined product to the American Refractories Co.

At the end of December, 1920, all the operations in Washington were stopped, principally, it is believed, on account of a lack of orders from the steel companies, many of which were idle or were not working full time. Some of the California producers were considerably discouraged at the end of the year on account of the high cost of labor and supplies, the high freight rates, and the competition of foreign material.

The imports of magnesite in 1920, reported by the Bureau of Foreign and Domestic Commerce as calcined, not purified, amounted to 43,154 long tons, valued at $780,078. These imports came from the following countries:

MAGNESITE IMPORTED INTO THE U.S., 1920

	Quantity (Long Tons)	Value		Quantity (Long Tons)	Value
Austria	......	$4	Scotland	190	13,720
Germany	713	28,566	Canada	6,028	184,060
Italy	21,185	241,220	Mexico	500	6,300
Czecho-Slovakia	3,829	126,827	Venezuela	2,300	11,500
Greece	4,000	38,418	Australia	34	417
Turkey in Europe	3,528	70,540	Straits Settlements	......	4
Netherlands	819	54,991			
England	28	3,511		43,154	$780,078

The magnesite imported from Italy was mined in Austria, and that from Czecho-Slovakia was obtained from the former Hungarian deposits. That imported from Mexico came from Santa Margarita Island and was calcined near San Diego, Cal. A shipment from Greece received in November was the first sent from that country since 1916. The arrival of 2,300 tons from Venezuela in September, 1920, was a notable event, as the recorded imports of magnesite from that country are meager.

Although the quantity of magnesite imported in 1920 was nearly three times as great as in 1919 it was only about one-seventh of the quantity commonly imported before the war.

Structure of Tungsten Steels

Review of Honda and Murakami's Work, Presenting Their Principal Conclusions as to the Structure and Constitution of Tungsten:Iron:Carbon Alloys — Reactions Between Iron Tungstide and Iron and Tungsten Carbides Are Responsible for Great Complexity

THE effects of tungsten in steel have been studied by many investigators, among them being Osmond,[1] Carnot and Goutal[2], Sir Robert Hadfield[3], Böhler,[4] Guillet,[5] Swinden,[6] Arnold and Read,[7] and Honda and Murakami.[8,9] The last-named investigators have carried out by far the most complete study of such alloys, and it is their work that will be largely here reviewed. As a result of their work with magnet steels containing from 0.35 to 0.60 per cent carbon and 4.8 to 6.2 per cent tungsten they reached in the main the following conclusions:

1. The presence of two carbides, Fe_3C and WC, in magnet steel as found by Arnold and Read is very probable. They can exist separately or as a double carbide, depending upon the heat treatment. After once heating to 800-900 deg. C. and slowly cooling, the two carbides exist as a double carbide.

2. Above Ac_1 this double carbide decomposes into its components, both dissolving in austenite and so remaining up to about 900 deg. C. On further heating the tungsten carbide dissociates into carbon and tungsten, both remaining in solid solution, while the tungsten dissolved in the austenite forms an iron tungstide Fe_2W. Degree of dissociation increases with rise in temperature, being practically complete at 1,100 deg. C.

3. By normal cooling from above 1,100 deg. C. the A_1, A_2 and A_3 transformations are lowered to a temperature below that of the normal A_1 point by the retard-

I $(Fe)+(4Fe_3C\cdot WC)+(Fe_3C)$,   *IV* $(Fe+Fe_2W)+(WC)$,
II $(Fe)+(4Fe_3C\cdot WC)+(WC)$,   *V* $(Fe)+(Fe_2W)+(WC)$,
III $(Fe)+(4Fe_3C\cdot WC)+(Fe_3C)+(WC)$. *VI* $(Fe+Fe_2W)+(Fe_2W)+(4Fe_3C\cdot WC)+(WC)$.

FIG. 1. STRUCTURAL DIAGRAM FOR TUNGSTEN STEELS

ing effect of the tungstide (Fe_2W) dissolved in the austenite. At about 550 deg. C. the retarded A_3 transformation begins to take place and with it the ferrite (with dissolved Fe_2W) separates from the solid solution. This continues for about fifty degrees till the concentration of the remaining mother solution reaches such a value that the A_1 transformation takes place at this temperature.

[1] *J. Iron & Steel Inst.,* 1890, No. 1, p. 61, 1903; No. 2, p. 106.
[2] *Compt. rend.,* vol. 125 (1897), p. 213; vol. 128 (1899), p. 208.
[3] *J. Iron & Steel Inst.,* 1903, No. 2, p. 59.
[4] *Wolfram und Rapid Stahl,* 1903.
[5] *Rev. Met.,* 1904, p. 263.
[6] *J. Iron & Steel Inst.,* 1907, No. 1, p. 291; 1909, No. 2, p. 223.
[7] *Proc. Inst. Mech. Eng.,* 1914, March 20.
[8] *Sci. Reports,* Tohoku University, vol. 6 (1917), p. 53.
[9] *Sci. Reports,* Tohoku University, vol. 6 (1918), p. 235.

In their later and more complete study of tungsten steels,[9] as well as in the investigation of magnet steels, Honda and Murakami largely used magnetic analysis, though this was supplemented by microscopic examination and such other tests as thermal expansion, thermal analysis, etc., where desired. In this investigation the magnetic transformations of cementite and of the double carbide of iron and tungsten occurring respectively at 215 and 400 deg. C. are of considerable interest and importance, for if the magnetization-temperature curve for a tungsten steel shows abrupt changes in the neighborhood of 215 and 400 deg. C. it is evidence that the steel contains respectively cementite and the double carbide, both in a free state.

MAGNETIC ANALYSIS

Applying magnetic analysis then to a series of iron:carbon:tungsten alloys containing from about 0.20 to 30 per cent tungsten and from 0.10 to 1.6 per cent carbon Honda and Murakami found:

I. That in steels containing a given quantity of tungsten—
   (a) Ar_1 and the double carbide transformations increase in magnitude with increase in carbon content.
   (b) The temperature required to lower the A_1 transformation is raised with increase in carbon content.
   (c) The completely lowered Ar_1 transformation has a definite value independent of the carbon content.

II. That in steels containing a given quantity of carbon—
   (a) Ar_1 decreases in magnitude as tungsten increases, vanishing with high tungsten content.
   (b) With increase in tungsten, the retarded Ar_1 is gradually lowered, up to about 9 per cent W. It remains constant with further increase in the tungsten content.

III. That the rate of cooling has a marked effect on the critical ranges. Rapid cooling from below the lowering temperature lowers Ar_1, while extremely slow cooling from above this temperature does not affect the position of this transformation.

CONSTITUTION

Based on this work, a structural diagram has been constructed which is shown in Fig. 1. Steels showing three transformations at 700 to 770 deg. C., 400 deg. C. and 215 deg. C. are represented by a dot inside a circle, those with two at 700 to 770 deg. C. and 400 deg. C. by a cross, and those having a single transformation at 750 to 780 deg. C. by a dot. Free constituents (as bracketed) in each of the six regions are given in the tabulation directly above the diagram. Magnetic transformations at 700, 400 and 215 deg. C. reveal respec-

tively the presence of ferrite, double carbide and free cementite, characteristic of steels coming in region I. With increase in tungsten, the free cementite decreases and finally is just sufficient to form the double carbide, when it disappears as a free constituent. As tungsten is further increased the proportion of tungsten carbide (non-magnetic) becomes excessive and it appears in the free state in steels of region II. But two magnetic transformations are obtained at 700 and 400 deg. C.

Steels high in proportions of tungsten and carbon contain free cementite, double carbide and tungsten carbide, for all of the latter does not combine with the cementite to form double carbide. This group of steels, III, may be distinguished from group II by magnetic
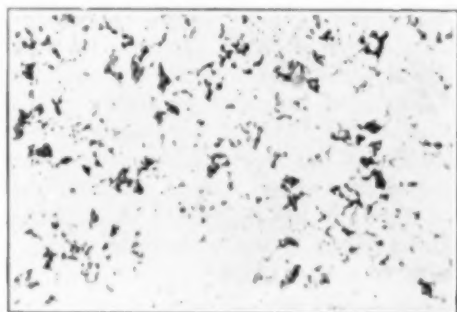
FIG. 2. STEEL CONTAINING 2.88 W, 0.19 C, SLOWLY COOLED FROM 860 DEG. C.
× 120

analysis. They show three transformations, occurring at 700, 400 and 215 deg. C.

Steels low in carbon with more tungsten than is required to form tungsten carbide (WC) contain iron tungstide, according to Arnold and Read[r] which is dissolved in ferrite in concentration equivalent to about 9 per cent tungsten. They belong to group IV. Steels in group V have higher tungsten content and more than can be held by the ferrite, so that they contain free tungstide.

Steels of group V with higher carbon form group VI and contain tungstide dissolved in ferrite, free tungstide, double carbide and tungsten carbide. The formula for the double carbide as determined by Honda and Murakami is $4Fe_3C.WC$. Likewise the authors ascribe, after careful study, the lowering of the Ar_1 transformation in general to the displacements of the eutectic A_1 transformation caused by the tungstide dissolved in ferrite. Since the latter dissolves the tungstide to a concentration equivalent to 9 per cent tungsten the lowering of Ar_1 will increase with increase in tungsten up to this concentration above which the excess tungsten remains undissolved and, therefore, does not affect the lowering.
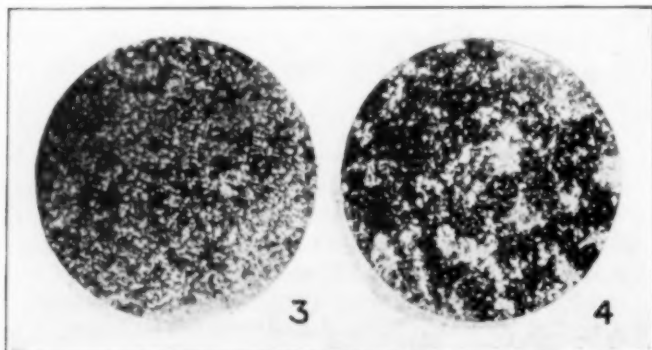
FIGS. 3 AND 4. STEEL CONTAINING 4.72 W, 1.57 C
Fig. 3. Slowly cooled from 900 deg. C. Fig. 4. Slowly cooled from 900 to 750 deg. C. and then quenched.
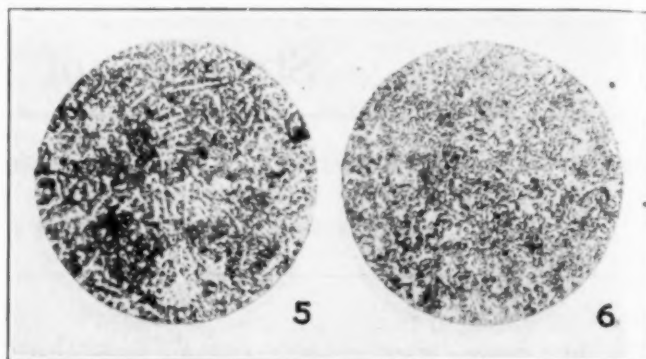
FIG. 5. STEEL CONTAINING 28.7 W, 1.07 C, SLOWLY COOLED FROM 900 DEG. C.

FIG. 6. STEEL CONTAINING 30.04 W, 0.51 C, SLOWLY COOLED FROM 900 DEG. C.

The rate of cooling markedly affects the position of Ar_1. Rapid cooling from the lowering temperature or below causes a depression in Ar_1 while slow cooling from the lowering temperature or above through 700 deg. C. results in the normal Ar_1 taking place. On normal slow cooling from about 900 deg. C. or other suitable temperature the following reaction occurs:

$$WC + 5Fe \rightarrow Fe_3C + Fe_2W$$
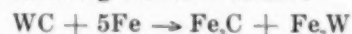
The higher the initial temperature and the lower the carbon the more this reaction proceeds from left to right. On heating a steel, with lowered Ar_1, to above
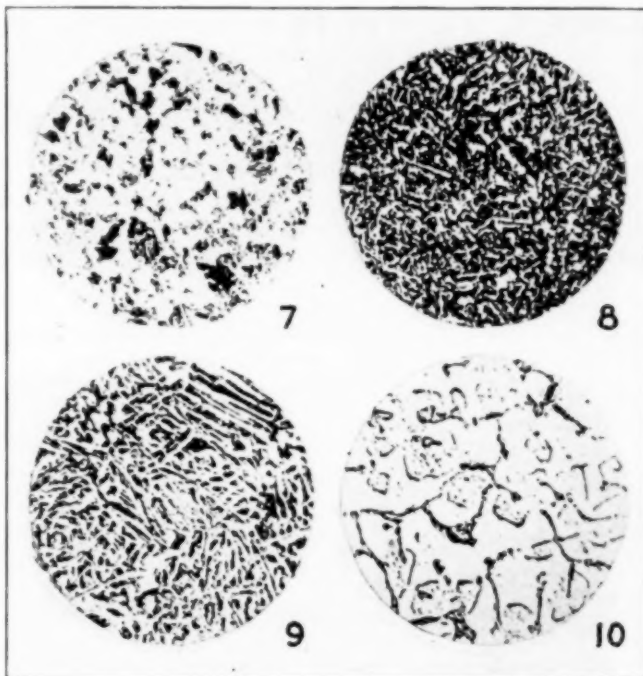
FIGS. 7, 8 AND 9. STEEL CONTAINING 2.06 W, 0.50 C, SLOWLY COOLED FROM 901, 952 AND 1,005 DEG. C., RESPECTIVELY

FIG. 10. STEEL CONTAINING 22.5 W, 0.27 C, COOLED FROM 1,300 TO 1,100 DEG. C. AND QUENCHED. ETCHED WITH SODIUM PICRATE

Ac_1 the reverse reaction takes place, so that on slow cooling the double carbide is again formed.

MICROSTRUCTURE

Normal structure of a tungsten steel may be regarded as meaning that obtained by heating to 850-900 deg. C. for twenty minutes and then cooling at the rate of approximately $\frac{1}{2}$ deg. C. per minute. The normal
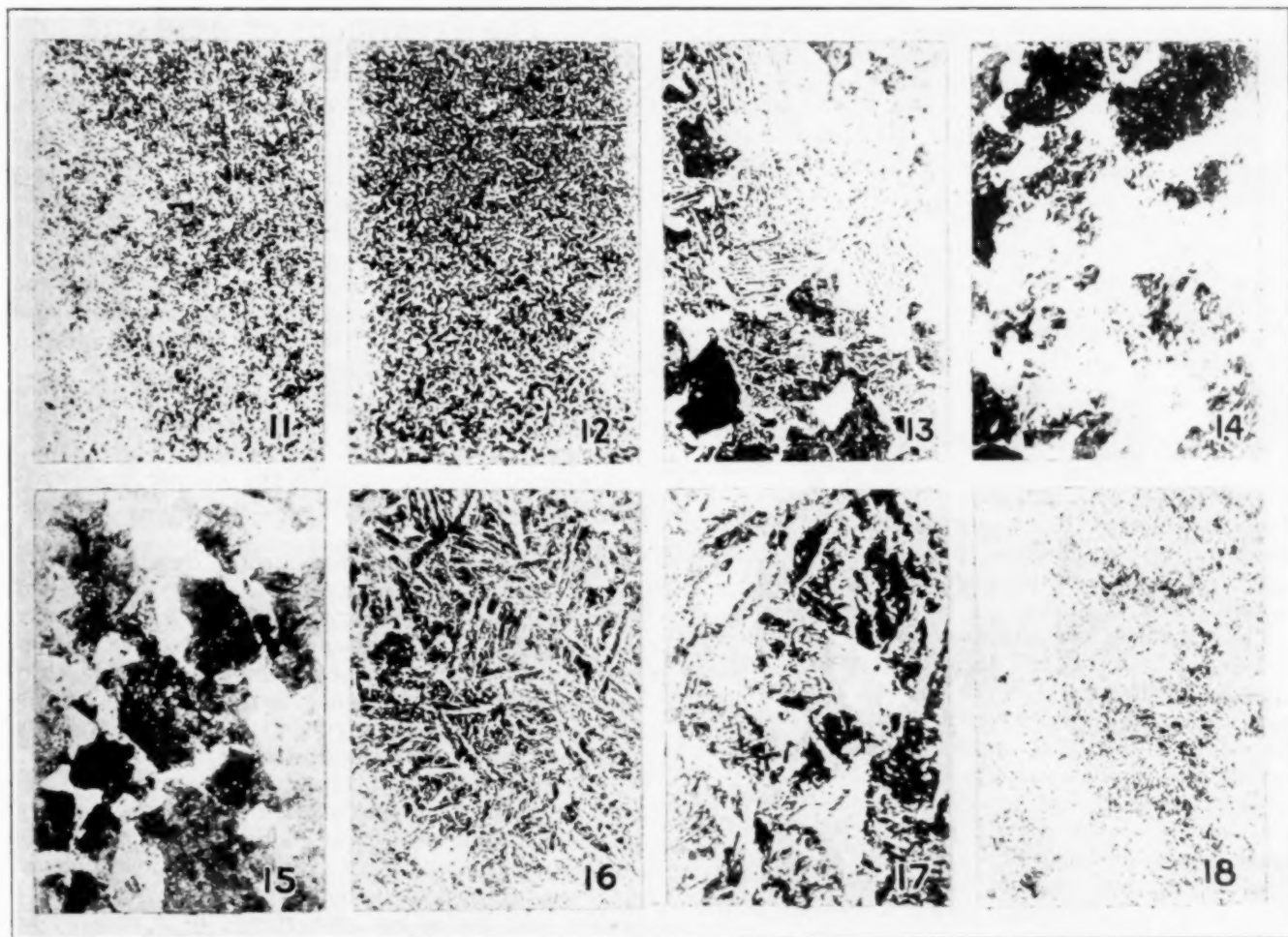
FIGS. 11 TO 18.　STRUCTURE OF 2.06 W, 0.50 C STEEL.　ALL × 120 EXCEPT FIG. 17

Fig. 11. Slowly cooled from 900 deg. C.

Fig. 12. Quickly cooled from 900 deg. C.

Fig. 13. Cooled during 20 min. from 1,100 to 700 deg. C.

Fig. 14. Cooled during 40 min. from 1,100 to 700 deg. C.

Fig. 15. Cooled during 51 min. from 1,100 to 700 deg. C.

Fig. 16. Slowly cooled from 1,100 to 550 deg. C.

Fig. 17. Same as Fig. 16, but magnified 360 dia.

Fig. 18. Quickly cooled from 1,200 deg. C.

structure of hypo-eutectoid steels of low tungsten content belonging to regions I and II are similar to those found in plain carbon steels, consisting of granular ferrite and eutectic matrix,[10] the latter not having the characteristic lamellar appearance of the pearlite of carbon steels (Fig. 2). Increase in tungsten content decreases the proportion of the latter and the ferrite becomes finer than in steels of similar carbon content without tungsten.

Steels coming within region III and hyper-eutectoid steels in region I have primary austenite which does not appear as a network, but as globules, which resemble the ferrite (Fig. 5). They may easily be distinguished from the latter, however, by their coloration in sodium picrate solution. The white globules in Fig. 6 are cementite (colored by treatment with sodium picrate). They are not the double carbide considered by Guillet[5] to be present in low-tungsten steels of high-carbon content, as the magnetization-temperature curve shows only the A_2 transformation and not that of the double carbide.

Though the steels of region IV contain some carbon, they do not show a eutectic matrix. Probably the carbon exists as WC, with which ferrite does not so combine.

Steels of regions V and VI contain iron tungstide in globular form, but have no ferrite even when the carbon

content is low (Fig. 6). Those of region VI in addition show a eutectic matrix as illustrated in Fig. 5.

Figs. 7, 8 and 9 show the effects of raising initial temperature on the normal structures of a steel containing two per cent tungsten and one-half per cent carbon. Both acicular and granular ferrites appear in Figs. 7 and 8, the former only being present in Fig. 9. Comparison with magnetization-temperature curves for this steel shows that where the normal transformations occur granular ferrite is obtained, and that the steels with lowered transformations show acicular ferrite. Specimens showing both normal and lowered ranges show both types of structure. Granular ferrite is pure iron set free above 700 deg. C., while the acicular type— iron containing tungstide in solid solution—is set free at the lowered Ar_2 transformation. The formation of such acicular ferrite is due to the simultaneous presence of dissolved tungstide and carbon in iron. The background of these micrographs is considered to be a eutectic of two constituents, first, ferrite containing tungstide and second, cementite. Eutectic structure is shown in Figs. 17 and 18.

By heating steels of region III and hyper-eutectoid steels of region I to about 1,200 deg. C., structural changes similar to those found in hyper-eutectoid carbon steels occur, the cementite appearing as network instead of globules. The globular form of cementite obtained in the normal structure of tungsten steels is ascribed to

[10]All etchings are alcoholic nitric or picric acid.

the presence of tungsten carbide. At or above 1,200 deg. C. this WC reacts with iron to form tungstide and cementite. The latter then separates, on cooling, in a network similar to that in ordinary carbon steels.

In a steel containing 4.72 per cent tungsten and 1.57 per cent carbon, cooling from 1,200 deg. C. followed by quenching at 750 or at 650 deg. C. (to find the separation of cementite on cooling) results respectively in production of austenitic-martensite and a network of free cementite, thus showing that Fe_3C separates below 750 deg. C. On the other hand, when cooling from 900 deg. C. cementite has already separated at this temperature (Fig. 4). Dissolved tungstide has therefore a retarding effect on the separation of primary cementite.

The effect of rate of cooling on a steel containing 2.06 per cent tungsten and 0.50 per cent carbon belonging to region VI of Fig. 20 is shown in micrographs of Figs. 11 to 18 inclusive. Very slow cooling from 900 deg. C. results in globular ferrite (Fig. 11), while with more rapid cooling from the same temperature acicular ferrite appears (Fig. 12).

The structures resulting from cooling through 720 to 670 deg. C., from 1,100 deg. C. in twenty, forty and fifty-one minutes are shown in Figs. 13, 14 and 15. They consist of large granular ferrite in network and acicular ferrite in mesh in Fig. 13, less of the latter in Fig. 14 and its final disappearance in Fig. 15, which consists of large granular ferrite crystals and a eutectic matrix. Thus on very slow cooling through 700 deg. C. the tungstide in solid solution reacts with Fe_3C to form free iron and tungsten carbide, a hypothesis confirmed by the magnetization-temperature curve showing both normal Ar_1 and double carbide transformations.

Figs. 16 and 17 are the structures resulting after normal slow cooling from 1,100 to 600 deg. C. followed by very slowly cooling to 540 deg. C. The structures consist of acicular ferrite and a eutectic matrix, showing that a temperature of 600 deg. C. is too low for the change to granular ferrite. Fig. 18, representing the structure of the same steel quickly cooled from 1,200 deg. C. to room temperature, shows fine acicular ferrite.

The effect of rate of cooling is not so marked on steels of region III and hyper-eutectoid steels of region I of Fig. 1, and has little or no effect on those belonging to regions IV, V and VI.

Calcareous Marl Produced in 1920

Reports made to the United States Geological Survey show that 97,487 short tons of calcareous marl, valued at $322,329, was produced in the United States in 1920. These figures represent an increase of 6.6 per cent (6,050 short tons) over the quantity produced in 1919, but a decrease of 1.5 per cent ($4,955) in the total value of the product. The average price per short ton was $3.31 in 1920 and $3.58 in 1919.

Most of the marl sold in 1920 was used in agriculture, in the same manner as pulverized limestone and agricultural lime, but some was used as a filler in patent fertilizer. In Arkansas, where the product included chalk, a small quantity was sold as whiting, which brought a higher price than the agricultural material.

Nearly one-half of the total output—42,510 short tons—was produced in Virginia and was valued at $143,373. The other producing states were Arkansas, California, New York, North Carolina, Ohio, South Carolina and West Virginia.

The Treatment of Acid and Alkali Burns*

By A. K. Smith, M. D.†

THE wounds caused in tissues by acids and alkalis are not strictly burns according to the accepted definition of a burn. Rather such chemicals belong to a class of materials known as escharotics or caustics, substances which when applied to living tissue cause its death and produce an eschar or slough. The strong caustics are sulphuric acid, nitric acid, potash, chloride of antimony, chloride of zinc, acid nitrate of mercury, bromine, chromic acid, lime and hot iron.

Applied to the skin, they immediately unite with it, killing the tissues to a depth proportionate to the strength and quantity of the caustic. Their burn is self-limited and immediately the caustic has exerted its strength by union with the tissues it is no longer destructive.

The burns may be conveniently classified just as burns from heat are classified: A first-degree burn in which only the epidermis is destroyed or inflamed; a second-degree burn extending into the true skin and causing its destruction or inflammation; and a third-degree burn which not alone destroys the skin but also extends into the underlying tissues. The treatment naturally varies with the degree of the burn.

The most important branch of treatment of these caustic burns is prophylaxis or preventive measures, and under this head come all the safety methods observed and the appliances used to render immediate aid in case of accidental spills.

You will notice hot iron classed as a caustic, and many of these innocent-looking liquid acids or solutions of caustic alkalis are quite as harmful as the hot iron.

First Aid for Burns

First aid, to be of any great value, must be immediate aid. Probably the most valuable is the shower bath, and of course it must be used before any attempt is made to remove clothing, and every effort must be made to get a large volume of water between the caustic soaked clothing and the skin. Directly after drowning the caustic, saturated watery solution of bicarbonate of sodium may be mopped on the burned area in the case of acid burns, and a 2 per cent solution of acetic acid similarly used in the case of alkali burns. After this has been liberally carried out the patient should be placed in a physician's care.

In simple first-degree burns mopping the burned area with dry gauze and the application of a bland, clean ointment, such as boric acid ointment or burn ointment—which is made of bicarbonate of soda and petrolatum—or oxide of zinc ointment may be used by spreading a liberal layer on gauze and holding it in place with a gauze bandage. Such a dressing relieves the pain and is sufficient with renewal of dressing occasionally.

In second-degree burns the wound should be cleansed of all loose rolled up epidermis, mopped with a mild antiseptic, such as boric acid solution, and an ointment applied on gauze, held in place by a rather loose gauze bandage.

In this degree of burn blisters are encountered.

Small blisters, unruptured, are let alone and larger blisters, where tension is likely to cause pain, are opened by first sterilizing the area with a $3\frac{1}{2}$ per cent alcoholic solution of iodine and a liberal incision is made with a sterile knife near the edge of the blister, allowing its top to collapse and remain. The ointment used in dressing these cases should be absolutely clean, sterile and mildly antiseptic, and should have a melting point that will insure its non-separation on standing in the surgery and still be of such consistency that it will spread with ease.

Care in Dressing and Cleaning Burn Wounds

The dressings are renewed as the judgment of the physician dictates, more often at first, when discharges are profuse; and later at as long intervals as possible, in order to allow healing to progress without disturbance.

The epidermis must grow over wherever it has been destroyed, and this growth takes place from the sound edges of the wound only. The newly formed epidermal cells are exceedingly delicate and are easily torn loose by the removal of a dressing, and it is for this reason that dressings should be changed only when absolutely necessary.

Third-degree burns are cleansed of all loose detritus and dressed with a sterile ointment as in second-degree burns. After three or four days the ointment dressing is replaced by a wet gauze dressing, using a sterile, normal, salt solution. The dressing must be kept wet by repeated applications of the salt solution.

A slough forms in these cases, necessitating a long wait until the sound tissue loosens and throws out the dead material, and all this must take place before healing takes place to any extent.

The use of wet dressings leaves the wound in a very favorable condition for skin grafting, should it become necessary.

The long time required for healing in these cases is due to the slow separation of the slough, and after that has taken place granulation tissue must fill up the sloughed-out spaces and a new epidermis grow to cover the entire area.

Healing may be hastened by a careful removal of portions of the slough when redressings are being made; also by keeping down excessive or exuberant granulation tissue growth; and, most important of all, by skin grafting.

The making of numerous small pin-point grafts, some of which will grow, will reduce the time of ultimate closure of the wound. In some cases larger grafts, by the Thiersch method, may be preferable.

Shock may be an accompaniment of second- and third-degree burns. It should be combated by a hypodermic of morphine, and the earlier it is given the better.

The patient is wrapped in hot blankets and surrounded with hot bottles or hot bricks. Care should be taken to cover the warming bricks or bottles with flannel or other material to prevent burning the patient. Salt solution may be introduced into the system by one of the various methods to increase the volume of blood. Ordinary stimulants given by the stomach are of little value in this condition.

Treatment for Burns of the Eyes

Burns of the eyes by caustics are given first aid by douching the eye with a watery solution of bicarbonate of soda in the case of acid burns and a 1 per cent or 2 per cent solution of acetic acid in alkali burns, after which a piece of boric acid ointment about the size of a pea is put under the eyelid and carefully worked into all corners by gentle manipulation on the outside of the eyelid. Further treatment of the eyes can best be done by an eye specialist.

In giving this, our treatment for caustic burns, I am aware of the various other treatments used in burn cases, many of which are not without good points; but I believe that the treatment as outlined will give the patient quicker relief from pain and quite as rapid a recovery and with as little scarring as any other method.

A Gas-Generating Apparatus

By Arthur W. Bull

IN SPITE of the many descriptions of gas generators found in the literature there are few satisfactory designs for the continuous supply of rather large quantities of gas, especially for hydrogen sulphide, where the offensive odor necessitates a gas-tight apparatus. The ideal hydrogen sulphide generator would be completely automatic; capable of delivering any desired quantity of gas at constant pressure; efficient in the consumption of acid and iron sulphide; odorless; and simple in design. The apparatus shown in the accompanying figure fulfills these conditions with one exception—namely, the gas is delivered with a slight fluctuation in pressure if the demand is discontinuous. For most purposes this is a negligible feature.

No startling innovations are claimed for the apparatus. It is rather a combination of previous ideas resulting in an improved generator using the principles of both the acid spray and the Kipp type.

Description of the Apparatus

A represents the acid container. For this purpose a constant level device of some kind must be used. A portion of an earthenware Parsons apparatus[1] was employed in the original apparatus, but a Mariotte bottle like A' or the arrangement of Browne and Mehring[2] can be used. The acid enters a small bottle B containing a layer of mercury. This layer acts as a check valve and prevents gas from escaping through the fresh acid. The distance XY must be as short as possible to prevent a siphoning effect. F, the gas outlet, leads to a gas-washing bottle not shown. C and E are tubulated bottles of convenient size and located at the same level. Ten-liter bottles were used, but these were considerably larger than necessary for supplying thirty students with hydrogen sulphide for qualitative analysis. D need only be a 2- to 4-liter bottle. C contains iron sulphide with a layer of broken glass or porcelain at the bottom. Old glass stoppers are excellent. The connecting tubes G should be of 12- or 14-mm. tubing. E is closed by a two-hole stopper with an outlet to the drain. The small bottle H, containing a thin layer of mercury, prevents the escape of hydrogen sulphide from the sludge and at the same time allows an admission of air to break the siphon IJ.

The apparatus is assembled with A empty at any convenient height greater than the desired gas pressure, above E and C. The minimum pressure of gas, in inches of water, desired at F is then decided upon. Six inches is satisfactory for most work. Water is added at E and

[1] *J. Am. Chem. Soc.*, vol. 25, p. 231 (1903).
[2] *J. Am. Chem. Soc.*, vol. 28, p. 838 (1906).

air is allowed to escape through F until water just reaches the iron sulphide in C. F is then closed and E is filled with water. F is carefully opened and water is allowed to flow from E to C until the difference between the levels in the two bottles equals the desired minimum head in inches of water. F is then closed; A is filled with dilute acid and the mercury layer in B is adjusted until the pressure of the acid column is just sufficient to overcome the back pressure of the mercury column in B and the air pressure in C. This is best accomplished by adding slightly more mercury than necessary and then carefully raising L until the dilute acid begins to drop on the sulphide. A short rubber tubing insert at N facilitates this operation. After the mercury layer is correctly adjusted F is opened and the apparatus is ready to function. No further adjustments are necessary and operation is entirely automatic. To obtain hydrogen sulphide open cock F. To stop operation close F. When assembly is completed the rubber stoppers
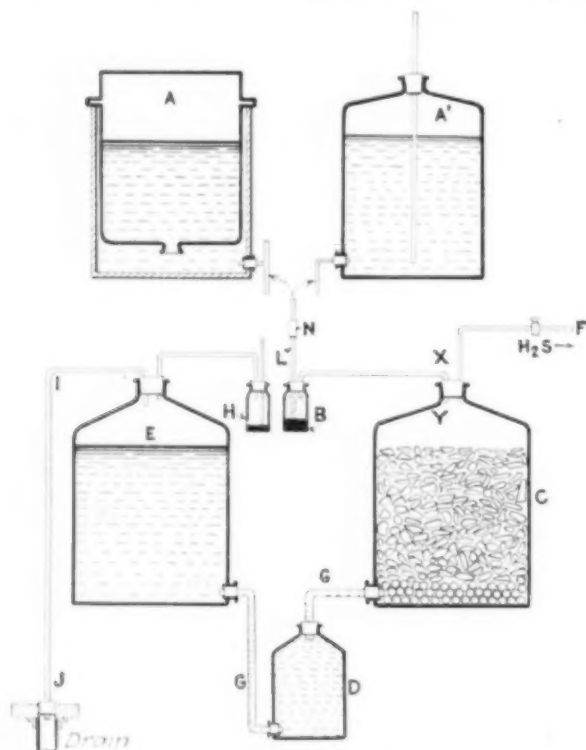
GAS-GENERATING APPARATUS

should be securely wired in place and given a coat of paraffine. Sulphuric acid can be used very satisfactorily but it must be greatly diluted to prevent crystallization of ferrous sulphate. The extent of dilution is dependent on the minimum temperature to which the apparatus will be subjected. If this temperature is 10 deg. the acid should not be stronger than 1:14. If 20 deg. is the minimum, the dilution is 1:11. Hydrochloric acid can be used diluted 1:1 or 1:2.

ADVANTAGES OF THE APPARATUS

When in operation, fresh acid drips down upon the iron sulphide until gas is generated at a rate greater than the demand. The level in C then drops and that in E rises, the increased pressure quickly shutting off the acid supply. No new acid will be admitted until the former supply, working on the Kipp principle, is unable to generate the required amount of gas. Because of the great surface of iron sulphide exposed to the action of the acid in this way almost complete neutralization of

the acid is effected. A titration of the sludge in E showed that 96 per cent of the acid had been utilized.

A freshly broken piece of iron sulphide was treated with dilute hydrochloric acid until a vigorous evolution of hydrogen sulphide was secured. It was then rinsed with distilled water and immediately immersed in a sample of the sludge. Only a very faint evolution of gas was observed. The sludge is automatically removed through the gas-tight connection with the drain. The difference in specific gravity between fresh acid and the sludge prevents dilution of the partly used acid in D.

The chief advantages of the new apparatus are:

1. Its operation is entirely automatic.
2. It uses acid with 96 per cent efficiency.
3. There is no chance whatever for the escape of gas into the room.
4. The apparatus is simple and easily made.
5. Extreme variations in demand are quickly met.
6. Gas can be generated at extremely high rates considering the size of the apparatus.

In case a high gas pressure is necessary, it can be secured by raising bottle E and reducing the mercury layer in B. The apparatus can of course be used for other gases than hydrogen sulphide.

Morse Hall,
Ithaca, N. Y.

Time-Punch Feature of Temperature Recorder

It is one thing to settle upon a specific working temperature as being most efficient in a given heat-treating process, but it is quite a different thing to maintain that temperature. No matter how accurate a heat-recording instrument may be, it can do no more than indicate fluctuations of temperature. The human element, untrustworthy at best, must be relied on to see that these fluctuations do not go beyond definite limits. If they do, the whole end and object of a recording thermometer is defeated. To meet these conditions the Schaeffer & Budenberg Manufacturing Co., Brooklyn, N. Y., has devised a time punch as an attachment to its recording thermometers which reduces the uncertainty of the human element to the lowest possible minimum. Making his rounds to inspect the temperature record, the operator in charge of temperature-control now registers the hour and minute of his visit by means of the time punch. Every time a temperature reading is taken he presses a little button and simultaneously a hole is punched in the margin of the revolving chart.

FACTOR OF CHANCE PRACTICALLY ELIMINATED

It can readily be seen that the factor of chance is in this way practically eliminated, because the operative knows that he is being checked. If he shirks his duties, the little punch holes will be conspicuous by their absence. The punch holes are either there or they are not there. If they are not in evidence, he has neglected to "ring up." If they appear at regular intervals and the chart still shows undue variations, there is undisputable evidence of his incompetence. Laxity or carelessness on the part of the operative, particularly where he has direct charge of the firing, is instantly made apparent. A superintendent may now give directions that temperature readings be made at regular intervals, with the knowledge that his instructions will be carried out.

The value of the time punch is apparent in any plant where accurate temperature control forms a part of routine processes.

Synopsis of Recent Chemical & Metallurgical Literature

Effect on Electrical Porcelain of the Replacement of Free Silica by Alumina and Zirconia.—The March *Journal of the American Ceramic Society* contains a paper by Robert Twells and C. C. Lin on the effect on electrical porcelain of the replacement of free silica by alumina and zirconia. Since it has been suggested that free silica may be detrimental to the mechanical and the dielectric strengths of electric porcelain, a series of sixteen batches was prepared in which various proportions of the free silica were replaced, weight by weight, by alumina, zirconia or combinations of both, and bars and disks, after burning at cone 8½ to 9, or at cone 12, were tested for shrinkage, transverse strength, impact strength, heat resistance, absorption of moisture and dye penetration. The results show that resistance to sudden temperature changes can be greatly improved by substituting zirconia, that the danger of overburning can be greatly decreased by substituting alumina and that the mechanical strength can be increased by substituting either or both; but in the case of dielectric strength no improvement was obtained by substituting for the free silica.

Rock-Drill Steel.—At the winter meeting of the American Institute of Mining and Metallurgical Engineers, an important symposium on Rock-Drill Steel was held. N. B. Hoffman, metallurgist of the Colonial Steel Co., noted that at the present time a large proportion of drill steel produced in America is manufactured into hollow rods. The process consists of first rolling or forging the ingots to suitably sized billets, approximately 4 x 4 x 24 in., which after thorough annealing are taken to drilling machines and a hole drilled through the long axis of the billet. Next one end of the billet is plugged, the cavity filled with a suitable refractory material, after which the other end is likewise plugged and the billets are ready for rolling. After rolling and cropping, the filling material is removed, and the bars are carefully inspected for physical defects. Solid drill steel is rolled direct; the billets are neither annealed nor drilled.

Some brands of hollow drill steel, especially products of foreign manufacture, are produced by a slightly different process, since the billets are pierced and rolled on a mandrel. The process has been observed on several occasions to produce numerous incipient cracks radiating from the hole in the bar, and ultimately producing a point of failure.

In forging the drill from a straight rod, the hammer end is heated to a high heat and upset to form a collar, after which it is allowed to cool. In most cases the strains set up by forging are severe; Mr. Hoffman personally believed after all forging has been finished, it would pay to thoroughly anneal and heat-treat the entire bar before hardening and tempering the point, at least where the drill has heavy duty such as working in deep holes and hard rock.

When hardening tools, especially multipointed bits, the blacksmith will often get one point harder than the other; consequently in use one point will wear down faster than the other, thus causing the drill to strike an uneven blow. Such things as these make for failures which cannot fairly be blamed upon the steel maker. What is needed today is a drill steel which will withstand impact and at the same time retain a sharp cutting edge—that is, a steel with a tough stiff body, and a point, when forged and hardened, that will be both hard and tough. A large number of tools of like character and the nature of whose work requires similar properties are now being made of alloy steels and used in the industries, to a very great extent displacing ordinary carbon steels, for instance a vanadium steel with a carbon content of 0.75 to 0.85 per cent, manganese 0.25 to 0.35, phosphorus under 0.020, sulphur under 0.030 and

vanadium 0.18 to 0.23, which has proved eminently satisfactory as a chisel steel. A steel of this type properly manufactured will be far superior to the ordinary carbon steels, while at the same time is one whose price range should not prove prohibitive.

Much of the cutting efficiency of a drill depends upon proper heat-treatment, and many drills are broken from being quenched at too high a heat, while others quenched at too low a heat do not harden properly and consequently dull quickly, but the driller, trying to get some duty from the dull bit, often breaks it due to the lack of the cushioning effect of slight penetration into the rock at each blow.

This heat range in the ordinary carbon drills is confined to rather narrow limits. The vanadium steel taken as an illustration has a far greater safe hardening and forging range, making it more nearly foolproof. It will harden nicely at 1,440 deg. F. but will also harden well and satisfactorily at 1,550 deg. F. retaining its quality of hardness and toughness in either case.

Influence of Manganese on the Tensile Properties of Malleable Iron.—The influence of manganese on the tensile strength and elongation of malleable iron has not been well defined; the general belief has been that 0.4 per cent manganese would be a maximum content for a good malleable iron. Dr. E. Leuenberger was studied this problem experimentally and describes the results of his work in the March 3 issue of *Stahl und Eisen.*[*] His samples were white iron

TABLE I.

Sample	Mn	C	Si	P	S
1	0.13	3.06	0.45	0.071	0.041
2	0.26	2.6	0.41	0.078	0.042
3	0.38	3.18	0.32	0.089	0.042
4	0.66	2.58	0.44	0.075	0.044
5	0.78	3.11	0.44	0.078	0.054
6	0.80	2.76	0.47	0.068	0.044
7	0.94	2.76	0.39	0.068	0.050
8	1.05	2.58	0.51	0.056	0.054
9	1.12	2.9	0.41	0.087	0.038
10	1.32	2.82	0.33	0.072	0.038
11	1.52	2.99	0.45	0.076	0.044
12	1.74	3.30	0.36	0.097	0.040
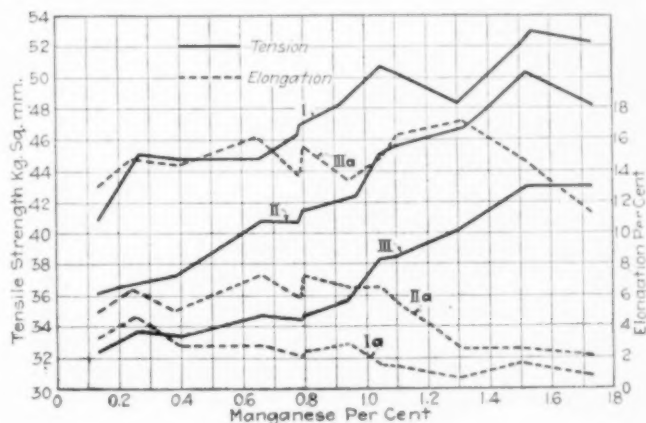
FIG. 1. INFLUENCE OF MANGANESE ON TENSILE STRENGTH AND ELONGATION OF MALLEABLE IRON

(1 kg./sq.mm. = 1,422.3 lb./sq.in.)
Curves I and Ia heating at 980 deg. C. for 95 hr.
Curves II and IIa heating at 980 deg. C. for 130 hr.
Curves III and IIIa heating at 980 deg. C. for 260 hr.

averaging 2.89 per cent carbon, 0.41 per cent silicon, 0.076 per cent phosphorus and 0.041 per cent sulphur, to which be added varying quantities of manganese in the form of a 50 per cent ferromanganese.

Twelve different analyses with manganese content varying from 0.13 to 1.74 per cent as noted in Table I were heated to 980 deg. C. in an oil-fired furnace for 95, 130 and 260 hours and tested in tension.

The test pieces were cylindrical bars 12 mm. in diameter. Six tests were made in each experiment and the resultant average was accepted as correct. These results are plotted

[*]"Einfluss des Mangans auf die Festigkeitseigenschaften des Schmiedbaren Gusses," *Stahl und Eisen*, March 3, 1921; p. 285.

in the accompanying figure in which the curves I and Ia, II and IIa, III and IIIa represent respectively the tensile strength and elongation of the samples heated for 95, 130 or 260 hours.

The conclusions derived are: (1) Manganese much above 0.4 per cent is permissible. (2) The tensile strength increases with increased percentages of manganese. (3) Elongation is not affected appreciably by increasing the manganese content up to about 1 per cent, but decreases with higher percentages. (4) The tensile strength decreases when the time of heating increases. (5) The elongation increases with the time of heating. (6) The longer the time of heating the higher the percentage of manganese needed for a given elongation.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Feeding Device for Sulphur Burners.—Referring to the figure, 11 designates the revolving drum of a sulphur burner having a frusto-conical end 12 into which the feeding device projects. The feeding device comprises a hollow body 13 carrying a supply hopper 14 and a feed screw 15. A spout 16 is provided at the discharge end of the body 13 and projects a short distance into the burner but not beyond the frusto-conical end 12. The spout comprises a cylindrical body, 17 having at one end a finished portion 18 which fits accurately within the body 13. Approximately two-thirds of the length of the projecting portion of the spout is cut away above the horizontal diameter, as indicated at 19, so that the discharge end of the spout is an open trough. This spout is considerably shorter than the spouts heretofore used so that it projects only a comparatively short distance into the burner. The open discharge end offers no resistance to the escape of sulphur so that the sulphur, which is advanced by the feed screw, does not

linger in the spout. The fact that the spout is open and exposes the sulphur to the heat of the burner is compensated for by the reduced length so that the sulphur melts very little, if at all, in the spout. The unrestricted opening allows any masses of partly melted sulphur to escape without blocking the spout. The sulphur is fed through a spout according to this invention in a substantially continuous and uniform manner and with much less power expenditure than heretofore. (1,370,627; FRED B. CHAPPELL, of Glens Falls, N. Y., assignor of one-half to Glens Falls Machine Works; March 8, 1921.)
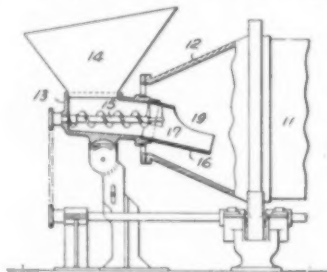
Vanadium Catalyst for Oxidation of Sulphur Dioxide.—A catalyst which effects conversion of sulphur dioxide and oxygen into sulphur trioxide with an efficiency of 96 per cent is obtained by distributing a vanadium compound on a very finely divided carrier not exceeding 60 microns in diameter. Pumice, kieselguhr, precipitated silicic acid, stannic oxide or stannic hydroxide may be used. The following method of preparation is given as an example: Mix 316 parts of kieselguhr (either as it occurs in nature or after trituration) which may previously have been heated to a red heat, with an aqueous solution of 50 parts ammonium vanadate and 56 parts of potassium hydrate; thereupon evaporate off so much of the water that the remainder can be formed into granules; place this result

in a furnace and heat at 480 deg. C. with gas containing sulphur dioxide and oxygen (such as can be obtained from a pyrites burner) and then, if desired, continue the heating for some time in a current of air; the product of this operation is a catalytic agent which is ready for use. (1,371,004; FRANZ SLAMA and HANS WOLT, of Ludwigshafen-on-the-Rhine, Germany, assignors to General Chemical Co.; March 8, 1921.)

Washing Vulcanized Fiber.—Vulcanized fiber made by treating paper with zinc chloride solution is washed free from zinc chloride in solutions of diminishing concentrations until pure water is reached. It requires three to four weeks to wash fiber ¼ in. thick. Such a lengthy process is necessary to prevent blistering and at the same time the economical recovery of the zinc chloride is made possible. The danger of blistering is minimized and the time required for washing is considerably reduced by the use of a process devised by OSCAR LINDER, of Chicago, Ill. The fiber is immersed in a zinc chloride solution in the cathode compartment of an electrolytic cell provided with a diaphragm. During electrolysis zinc separates at the cathode and chlorine at the anode so that the strength of the electrolyte decreases gradually and at a uniform rate. The fiber is not connected to the cathode in any way, but is simply placed in the electrolyte so that the removal of the zinc chloride from the fiber is due to direct diffusion of the salt into the surrounding solvent. (1,371,698 and 1,371,699; assigned to Western Electric Co.; March 15, 1921.)

Removing Tar From Pyroligneous Liquids.—The pyroligneous liquors obtained by the distillation of wood are always highly colored due to the presence of tars. Calcium and sodium acetates made from these liquors also contain these tars, which must be destroyed by roasting. The tar can, however, be removed from the liquors before preparing the acetates by using a solvent which is non-miscible with water such as cresol. In making the extraction, EMILE A. BARBET, of Paris, France, suggests the use of a quartz- or coke-filled tower, the pyroligneous liquor being introduced at the top of the tower, and the cresol near the bottom. The tarry cresol which rises to the top is drawn off and distilled to recover the cresol. The decolorized liquor which is drawn off at the bottom of the tower is practically free from tar. The process may also be applied in other industries. (1,371,460 and 1,371,461; March 15, 1921.)

Electrodeposition of Nickel.—Nickel plating with the customary solution of nickel ammonium sulphate is a comparatively slow process, due to the fact that only a 7 per cent solution can be obtained. It has been proposed to use a concentrated solution of nickel sulphate as the electrolyte or plating bath of a nickel-plating electrolytic cell, as it is possible to obtain a 37 per cent solution of this salt, and consequently with such a bath it is possible to impress a current on the cell sufficiently high to plate the nickel out of the bath onto the cathode about five times as fast as is the case when a concentrated solution of nickel ammonium sulphate is used for the electrolyte. However, in cells heretofore used in which a concentrated solution of nickel sulphate is employed as the plating bath, the latter quickly becomes acid. This is due to the fact that in the operation of such cells the nickel dissociated or separated from the nickel sulphate is plated on or taken up by the cathode more rapidly than it is replaced by nickel from the anode, or in other words, more rapidly than the nickel from the anode combines with the SO₄ dissociated from the nickel sulphate by the electric current. Consequently, the excess of SO₄ combines with hydrogen dissociated from the water in the solution by the electric current, to form sulphuric acid. The amount of sulphuric acid so formed continually increases and as this acid acts to dissolve the nickel deposited or plated on the cathode, the efficiency of such cells is soon lost. Moreover, the plating baths of such cells soon become dirty and scum rapidly accumulates on the surface. THOMAS A. EDISON, of Llewellyn Park, West Orange, N. J., maintains the neutrality and composition of a concentrated nickel sulphate bath by circulating it rapidly and continuously through a filter press containing porous cakes of nickel hydroxide. (1,371,414; March 15, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Plans for Chicago Meeting, A.S.M.E.

The 1921 spring meeting of the American Society of Mechanical Engineers is to be held in Chicago, May 23 to 26, at the Congress Hotel.

Well-developed programs will be presented by the professional divisions of the society devoted to Forest Products, Fuels, Machine Shop, Management, Material Handling, Power, and Railroad, and a specially important session will be devoted to Training for Industries. The Chicago committee, jointly with the Western Society of Engineers, is preparing a session on "Chicago as the Rail-Water Gateway."

Visits to a number of points of engineering interest in Chicago will be arranged. Special attention is being given to the correlation of plant visits with the technical sessions.

En route to the meeting, the society, jointly with the Society of Automotive Engineers, will stop at McCook Field on Saturday, May 21, for an inspection of the facilities of the field. On May 27 and 28, the Friday and Saturday following the meeting, a joint excursion with the Army Ordnance Association will proceed to Rock Island Arsenal, where the Ordnance Division will present papers and enjoy an inspection of the plant. Saturday will be devoted to a handicap golf tournament on the Rock Island links.

Government Kelp Products Plant to Be Sold

The kelp products plant of the Bureau of Soils at Summerland, Cal., must be sold, under the provisions of the agricultural appropriation bill passed by the last session of Congress. This plant, which is now operating for the production of bleaching carbon, potash salts and iodine, has a capacity of about 100 tons of wet kelp per day. From this it is estimated there can be produced 1,500 lb. of bleached carbon and 2 tons of potash salts daily.

The officials of the Bureau of Soils had hoped to continue the experimental operation of the plant for another year, as by that time they felt certain that it would be generally admitted that the operation was a demonstrated commercial success. However, Congress deemed otherwise and it is now necessary to dispose of the plant as soon after the first of July as a purchaser can be secured. The bureau states that it will make very favorable terms for disposal of the property if it could be assured that the plant will be operated for a sufficient time to demonstrate its possibilities thoroughly. In fact there appears to be more interest in securing a guarantee of operation to complete the experimentation now under way than in realizing any large sum from the sale of the property.

Muscle Shoals Work Stops

Practically all of the work at Muscle Shoals has been stopped. Enough of the money already appropriated for the Wilson dam has been retained to provide for the maintenance of the unfinished project until August, 1922, which is regarded as the earliest time at which new funds are likely to be made available. Enough money also has been withheld to provide for an investigation of the rock beneath the south abutment of the dam as there have been some evidences of instability at that point.

To Examine Georgia Mineral Deposits

The Bureau of Mines is co-operating with the Central of Georgia R.R. in an examination of the clay, feldspar, graphite and bauxite deposits tributary to that railroad. The Bureau of Mines is represented by R. T. Stull, superintendent of its ceramic station at Columbus, Ohio, and by W. M. Weigel, its mineral technologist attached to its Southern experiment station.

Entertainment for Mme. Curie

As Mme. Curie is expected to be but a very short time in New York City, and as it would be impossible for her to attend functions given by any of the individual societies, a luncheon will be given in her honor by the associated chemical societies at the Waldorf-Astoria, on Tuesday, May 17, at 12:30 p.m. Price per cover is $5. Brief addresses will be made by representatives of each of the chemical societies.

The following gentlemen comprise the committee on arrangements: Chairman, Dr. Edgar F. Smith, American Chemical Society; vice-chairman, Dr. W. S. Landis, American Electrochemical Society; Dr. S. R. Church, Society of Chemical Industry; Dr. George F. Kunz, Société de Chimie Industrielle; secretary-treasurer, Dr. J. E. Zanetti, Chemists' Club of New York City.

Other committees appointed in connection with the luncheon are:

In charge of arrangements with the Waldorf-Astoria Hotel—Dr. George F. Kunz.

Seating—S. A. Tucker, chairman; H. B. Coho, C. A. Doremus, R. H. McKee, J. M. Matthews.

Speakers—Charles Baskerville, chairman; Colin G. Fink.

Program, invitations, music and flowers—Ellwood Hendrick, H. R. Moody, Reston Stevenson.

The following have been appointed to represent their respective societies on the entertainment committee for the entire duration of Mme. Curie's visit:

American Chemical Society—Leo H. Baekeland, Yonkers, N. Y.; Marston T. Bogert, Columbia University, New York City; Prof. J. Enrique Zanetti, Columbia University, New York City; R. B. Moore, U. S. Bureau of Mines, Washington, D. C.; Wilder D. Bancroft, 7 East Ave., Ithaca, N. Y.; Charles F. Chandler, Columbia University, New York City; Charles L. Parsons, 1709 G St., Washington, D. C.; Charles H. Herty, 1 Madison Ave., New York City; W. H. Nichols, 61 Broadway, New York City; Ira Remsen, Johns Hopkins University, Baltimore, Md.; T. W. Richards, Gibbs Memorial Laboratory, Frisbie Place, Cambridge, Mass.; W. A. Noyes, University of Illinois, Urbana, Ill.; S. C. Lind, U. S. Bureau of Mines, Golden, Col.

New York Academy of Sciences—George F. Kunz, chairman; Edward L. Thorndike, Ralph W. Tower, F. A. Lucas, William J. Gies.

American Electrochemical Society—W. S. Landis, president; Colin G. Fink, J. W. Richards, H. B. Coho, E. P. Matthewson.

Society of Chemical Industry—H. G. Carroll, Prof. Ralph H. McKee, Charles H. Herty; S. R. Church, chairman; Allen Rogers, secretary, ex-officio.

Société de Chimie Industrielle—Leo H. Baekeland, Marston Taylor Bogert, Charles A. Doremus, George F. Kunz, chairman; J. Enrique Zanetti.

New York Electrical Society—W. N. Dickinson, president; T. Commerford Martin, C. O. Mailloux, A. L. Doremus, George H. Guy, secretary.

Cooper Union Chemical Society—Prof. Henry C. Enders, George Felder, president.

Following is the text of the appeal by the Marie Curie Radium Fund, which has the task of raising money with which to purchase a gram of radium to present to Mme. Curie in the name of the women of America:

"Women of America are raising a fund of $100,000 with which to buy a gram of radium for Mme. Curie, who has none with which to continue her research work. It is the one thing most desired by this great scientist. You may aid this fund by subscribing in the name of a woman. Make your check payable to the Marie Curie Radium Fund and send it to the Equitable Trust Co., 37 Wall St."

Chemical Warfare Service Dinner

That the Chemical Warfare Service can rely in the future on general support both within and without the Army became very evident at its third annual dinner held in Washington, April 16. Much significance is attached to the remarks at the dinner of E. J. Wainwright, Assistant Secretary of War, whose warm support of the service hardly would have been forthcoming were it not the attitude of the Administration. The speeches made at the dinner have aroused much comment, particularly in military circles. The Rip Van Winkles in the Army who have been anti-C.W.S. show signs of revising their views with respect to chemical warfare.

The toastmaster at the dinner was Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*. In introducing General Fries he told of the great interest which the 15,000 chemists of the United States have taken in chemical warfare since its introduction into the World War and the very general desire among these chemists to have the public generally awake to the possibilities of this new weapon and to be reliably informed as to all phases of its use.

ADDRESS OF GENERAL FRIES

General Fries in the course of his address declared that he believes in publicity. Were a screen of secrecy drawn across the work of the service, he thinks it would have an adverse affect upon the support given a new activity concerning which there is a great deal of misinformation afloat. General Fries told those assembled at the dinner how the toxic smoke-candle has revolutionized cloud-gas practice and how liquid gas has been improved until it truly is the "dew of death." The battlefield of the future, he declared, never will be free of gas. He analyzed the great advantage which the United States enjoys in having the raw materials needed to make these gases and a great industrial machine which can be diverted to the making of gases in time of war, as well as having the trained personnel which would be required for that service. In concluding his remarks he said:

"The Chemical Warfare Service will guarantee to keep the United States in the very forefront of chemical warfare investigation, development, production and training for just 2 per cent of the Army appropriation, and if the Navy desires it, we can do the same for it for about 1 per cent of the Navy appropriation. With 2 per cent of the Army appropriation we will manufacture all masks needed in peace, including a suitable reserve. We will keep in condition a plant that in time of war will produce masks as fast as men can be mobilized and in addition keep them equipped in the field. We will keep in readiness plants for the manufacture of gases and for the filling of gas shells, bombs and other containers on a scale to meet the needs of any war. We will be able to lead the world in research and development, and we believe that with that 2 per cent we could do as much to guarantee success in war as 25 per cent spent for any other purpose."

PRESIDENT'S PHYSICIAN INTERESTED IN C.W.S.

Brigadier-General Charles E. Sawyer, recently designated by the President to be his personal physician, who was the second speaker on the program, revealed to official Washington that he is an orator and that he has done some sound thinking on public questions. He told of his own interest in chemistry and declared that physicians should use more chemistry in their efforts to diagnose diseases. He stated that he had been impressed particularly with the good which would come in peace time from the research and other activities of the Chemical Warfare Service.

AIR SERVICE RELIES ON GAS

That the Air Service of the Army is relying chiefly upon gas for its war-time effectiveness was indicated by the talk of Brigadier-General William Mitchell, assistant to the chief of the Air Service. He pointed to the vulnerability of New York, where millions of people live within an area of a few square miles. If an enemy were able to get one airplane over the city once in eight days so as to drop two tons of tear gas, it would be necessary for every person in an area of 100 square miles to wear gas masks continuously. If one bombardment squadron, he said, were able to force its way over the New York area once in eight days, it would be possible to drop 70 tons of mustard gas, which then would make it necessary for the entire populace to take further steps to protect itself against that gas. Only two bombing squadrons would have to pass over the New York area once every eight days to drop 200 tons of phosgene, which would make the entire city untenantable. H. C. Parmelee, Editor of CHEMICAL & METALLURGICAL ENGINEERING, advocated adequate financial support for C.W.S. by Congress.

GAS WARFARE BY THE NAVY

Following Mr. Parmelee's remarks Rear Admiral W. S. Smith, of the Naval Consulting Board, was introduced. He declared that the Navy is entertaining no delusions as to

CHEMICAL WARFARE SERVICE DINNER, WASHINGTON, D. C., APRIL 16, 1921

the possibilities of gas and that it may be taken for granted that the Navy will be found prepared in that particular. He stated that he favors allotments from the naval appropriations to the Chemical Warfare Service so that it may manufacture the gas needed by the Navy. He said that those doubting the effective use of gas bombs dropped by airplanes against battleships are influenced by the fact that hits seldom are recorded. He admitted that may be the case when a few bombs are dropped at a target, but it would not be the case when a large fleet of airplanes dropped hundreds of bombs simultaneously. Ships must be made gas-proof, he declared.

WILL BE READY FOR NEXT WAR, SAYS WAINWRIGHT

In addition to his remarks supporting the Chemical Warfare Service, Assistant Secretary of War Wainwright declared with emphasis that the United States will be ready for the next war, whether that war be a conflict with a single nation or any combination of nations. He is anxious to have the Army maintain sufficient supplies to enable it to make war without having to draft into service nearly all the productive power of the country's manufacturing plants. He also referred to the necessity of equipping plants so as to make them readily convertible to war needs.

DR. BANCROFT WOULD INTEREST ALL CHEMISTS IN CHEMICAL MEANS OF WAGING WAR

Dr. W. D. Bancroft pointed out the necessity of keeping the chemists of the country interested to the point that they will have in mind at all times the improvement of chemical means of making war. He stressed the point that every man in the military service in the future must be equipped with a certain amount of knowledge as to gas. He made the point that research alone is not enough. Military tactics must be developed and essential training of military personnel must not be overlooked. The mask particularly is subject to great development. No real fighting mask has been developed as yet, he declared.

CONGRESSMEN SPEAK ON PREPAREDNESS

Following the set speeches, Representative Frank W. Mondell of Wyoming, the Republican floor leader, and Representative Julius Kahn, the chairman of the Committee on Military Affairs, were invited to talk. Mr. Mondell emphasized the need for economy in public expenditures, but referred to a proper degree of military preparedness as insurance on which the nation must pay the premium. The development of a new weapon in warfare must not be disregarded, he declared. If other nations should pretend to abandon the use of gas in war, he ventured the assertion that it would be because they are afraid of our prowess in that direction.

Representative Kahn takes no stock in the assumption that wars are things of the past. He stated that it has been his constant effort throughout his public career to strive for a high degree of military preparedness in the United States. Had there been more preparedness before this war, the nation would be much better off today, he asserted. Had it been possible in recent years to secure an annual investment of $50,000,000 for preparedness measures, the nation would be the gainer by an untold amount today and the very war itself might have been averted. As it is, $25,000,000,000 was expended in the World War. Thus in a few short months enough was expended to make annual payments of $50,000,000 for more than four hundred years. He was particular to call attention to the fact that the cost in money represents only the replaceable part of our loss. The lives that were sacrificed and the suffering that was endured, he declared, are losses which head the list in our calculation. He said the Chemical Warfare Service should be given the $7,000,000 appropriation for which it had asked.

The dinner and the program of speeches were voted by all in attendance to have combined to make an evening long to be remembered. The committee which had charge of the arrangements consisted of Lieutenant-Colonel H. L. Gilchrist, Major R. F. Maddux, R. S. McBride, W. F. Keohan and Dr. A. W. Shaw.

Corrosion and Its Prevention

The program of the Connecticut Valley Section of the A.C.S. calls for one joint meeting yearly with the Hartford Branch of the American Society of Mechanical Engineers. This meeting was held Monday, April 11, following a dinner at the City Club of Hartford.

A paper on "Corrosion and Its Prevention" was read by W. T. Becker of E. F. Houghton & Co., and Dr. A. S. Cushman of the Institute of Industrial Research gave a talk on the fundamental causes of corrosion, with particular reference to the iron and steel industries.

Mr. Becker said that the mechanical engineer was concerned with the temporary protection of iron or steel surfaces against corrosion. After the article in question had reached its destination and been installed the problem of rust prevention ceased to be of interest to him. After dwelling briefly on the electrolytic theory of corrosion he went on to speak of the importance of proper selection of steel for the particular purpose in view. By selecting a steel having the highest possible drawing temperature which will possess the desired properties there results a product in which the steel is less likely to be strained and consequently less likely to develop electropositive spots resulting in rapid corrosion. He listed the practical methods of rust prevention as (1) the use of inhibiting agents (generally, however, in conjunction with painting), (2) painting, (3) covering with a film of oxide, (4) covering with some other metal, zinc, copper or tin in practice, and (5) covering with a non-drying coating as greases or slushes.

Small machine parts, he said, must nearly always be protected by means of the last class of protective agents, for the coating must be readily removed. A great deal of research has been carried out with regard to the development of proper slushing compounds and many good ones have been developed. The two sources of trouble in this class of materials are found to be checking or cracking if the object is cooled too much, and liquefaction of the grease if the object is warmed. Shipments to the tropics demand a different sort of slushing compound than do shipments in colder regions. A very good test for the efficiency of such a grease consists in coating a test-piece in the ordinary way and then hanging it in fumes of hydrochloric acid. If the film of grease is not perfect, it will be quickly apparent. Another good test consists in coating a test-piece with the grease, hanging it in 5 per cent salt solution for twenty-four hours and again coating and immersing until the grease fails. The paper used for wrapping small parts is frequently a source of corrosion. It should contain neither acid nor sulphates.

Dr. Cushman spoke very interestingly of his early work in the field of corrosion. He described the origin of the investigation as due to complaints of farmers in the Middle West about the deterioration of fence wire and told of his earlier experiments leading up to his electrolytic theory now universally accepted. Some slides which he showed made up of wire nails in gelatine containing phenolphthalein and potassium ferricyanide brought out the positive and negative portions very vividly, and one in particular showed the presence of a field of force about a spot in the surface of a bit of steel wire. The lines of force showed up very clearly in the gelatine and should be sufficient to convince any skeptics of the validity of the electrolytic theory of corrosion.

He went on to point out the importance of many recent discoveries in the "higher physics and higher chemistry," as he called them, to practical industrial problems, but he felt that much more knowledge of the fundamental properties of atom and molecule was necessary before the problem of preventing corrosion could be solved.

The Underwood Typewriter Co. allowed the visitors to inspect its factory. A large number of members availed themselves of the opportunity.

Navy to Use C.W.S. Masks

The gas mask developed by the Chemical Warfare Service has been adopted tentatively for use by the Navy.

Last of Government Surplus Brass Sold

All the remaining surplus of brass cartridge cases has been sold by the War Department. The bulk of this surplus brass recently was sold to the Chase Companies, Inc., the Scovill Manufacturing Co. and the Bridgeport Brass Co. The remainder has been allocated as follows: Western Cartridge Co., East Alton, Ill., 2,074,554 lb.; American Copper Products Corporation, Bay Way, N. J., 2,000,000 lb.; Baltimore Tube Co., Baltimore, Md., 500,000 lb.; Wheeler Condenser & Engineering Co., Carteret, N. J., 1,746,812 lb.; Seymour Manufacturing Co., Seymour, Conn., 2,009,306 lb.; Keeler Brass Co., Grand Rapids, Mich., 761,800 lb.; British American Metals Co., Inc., Plainfield, N. J., 2,000,000 lb.; Ansonia Foundry Co., Ansonia, Conn., 1,500,000 lb.; Standard Underground Cable Co., Pittsburgh, Pa., 1,553,045 lb.

Chicago Chemists Club Party

The Chicago Chemists Club gave a party in headquarters, 315 Plymouth Court, on Friday evening, April 15. It was a social occasion or ladies' night in honor of the inauguration of the new president, Otto Eisenschiml. The evening's program was devoted entirely to entertainment. After dinner an informal reception was held in the club lounge for Mr. and Mrs. Hoskins and Mr. and Mrs. Eisenschiml, followed by dancing and a musical program. Later in the evening a smelling contest was held where eighteen unknown substances were offered to the ladies for identification and twenty-four difficult odors were tested out by the men. The attendance of members and guests broke all previous records.

Navy Interest in Chemical Warfare Is Intense

The Navy is making no effort to conceal its very active interest in the experimental and research work being done by the Chemical Warfare Service. The General Board of the Navy, headed by Rear Admiral W. L. Rodgers, recently has spent considerable time familiarizing itself with the work being done at Edgewood.

The contrast between the interest displayed by high naval officers, as compared with that shown by the General Staff of the Army, is a cause of comment. A change in the policy of the General Staff, however, may take place when the appointee of the new administration takes over the direction of its work.

Plans for Recovery of Wastes at the Holland-St. Louis Sugar Plant, Decatur, Ind.

Following months of scientific research by engineers in which officials of the State Department of Conservation cooperated with officials of the Holland-St. Louis Sugar Co., of Decatur, Ind., and the State Board of Health, Richard Lieber, Director of Conservation, has announced that a plan has been adopted by which it is expected to free St. Mary's River from pollution caused from vegetable matter and refuse from the sugar refinery.

The plan, which has the approval of the Conservation Department, heads of the engineering department of Purdue University, the State Board of Health and the Holland-St. Louis Co., will involve an expenditure by the latter of approximately $104,000 for the erection of a plant to handle and dispose of the refuse in such a way as to reclaim the byproducts. This plan, engineers claim, will recover potash for use as fertilizer, will increase the sugar yield, and such wastes as eventually will reach the river will have been so purified that all contaminating influences are lost.

The wastes from the plant may be divided as follows: (1) Beet-carrying and wash water, 2,000,000 gal. per day. (2) Diffusion battery and pulp press water, 200,000 gal. per day. (3) Lime press cake, 37 tons as a solid cake containing 50 per cent moisture, or 150,000 gal. when diluted with water to make a liquid that will readily flow. (4) Steffens house wastes, 200,000 gal.

No. 1 waste contains beet tails, beet tops, earth and beet roots, but very little soluble organic matter. Its biolog-

ical oxygen demand is zero. It is therefore planned to keep this liquid separate from the other wastes, which can readily be accomplished, pass it through fine screens and discharge it continuously into the river.

DIFFUSION BATTERY WATER RE-USED

No. 2 waste contains much organic matter in solution and also considerable in suspension. Very careful consideration was given to treatment of these wastes and methods were actually devised for coagulating and settling them so that the supernatant liquid could be discharged into a storage lagoon and from there permitted to flow in the river at a rate more or less proportional to the stream flow, so that the stream at no time would be excessively polluted. However, there was finally worked out with the assistance of the company superintendent a method for re-using these wastes. This method is not altogether new, but it is novel in that the wastes will all be recirculated into the process. Treatment comprises liming and carbonating in a manner similar to the treatment applied to the main volume of juice in the plant and then re-using the liquid in the diffusion batteries. The purpose of the liming and carbonating process is to precipitate out non-sugars, which are then filtered off, leaving as a waste a lime press cake which, however, will not greatly increase the volume of lime press cake already produced.

LIME PRESS CAKE

The lime press cake may be handled either as a relatively solid cake or as a rather thick liquid. If handled as a cake, it would be removed from the factory on a small narrow-gage railroad and dumped at some convenient point where dumping grounds are available. This method, while perhaps the cheapest available, is objectionable, inasmuch as it involves considerable labor. Labor is always hard to get at beet sugar plants because the "campaign" lasts for only 100 days. Accordingly the company favored mixing the cake with water (which water incidentally is used for assisting in the cleaning of the presses) and pumping it to lagoons, where it will be stored until the volume of flow in the river is sufficient to afford ample dilution. It is estimated that a storage capacity sufficient to hold 25 days' production of the liquid lime cake will tide over any period of insufficient dilution in the river that is likely to occur.

POTASH RECOVERED FROM STEFFENS WASTE

The fourth waste is exceedingly strong in organic matter, though low in suspended solids. It results from the process used to recover additional quantities of sugar from the molasses after the first direct recoveries have been made. This waste will be evaporated to dryness in multiple effect evaporators and the final sirup will be ignited for the recovery of potash. It is probable, however, that the ignition process will not be conducted at the plant, but the sirup itself will be barreled and sent to fertilizer works. This process of recovering potash is not new and in fact was used at this plant before. The building in which it was housed burned down in 1918 and owing to the unfavorable market for potash that developed subsequently it was never rebuilt. It is not likely now that the process will pay for itself owing to continued unfavorable potash market. However, when looked upon as a method for treating the wastes, it is reasonably economical.

BIOLOGICAL PROCESSES NOT APPLICABLE

It is to be noted that ordinary methods of sewage treatment involving biological processes are difficult to use in connection with beet sugar wastes for the reason that the campaign runs for only 100 days and it would take any biological process at least several weeks to ripen, during which period most of the damage would have been done in the matter of stream pollution, inasmuch as the campaign is started in October when stream flows are ordinarily low. Another objection to biological processes is that the waste carries so much organic matter that very extensive filter areas are necessary to give the desired capacity. This makes biological processes exceedingly expensive.

Imports and Exports of Chemicals

Imports of chemicals decreased in a very unusual manner during February. Total imports for the month were valued at $7,434,811, as compared with $16,460,296 in February of 1920. The total imports of January, 1921, were $12,221,850. Thus there was a decrease over the corresponding month of last year of more than $9,000,000, while the decrease from January was nearly $5,000,000. The figures are those of the Bureau of Foreign and Domestic Commerce.

The decline came largely among the gums — camphor, copal, gambier and shellac. There were slight increases in imports of colors and dyes and in coal-tar products. Outside of the major group some of the imports were as follows:

	Feb.,1920 Pounds	Feb., 1921 Pounds
Iodine	6,975	55,846
Lime, chloride of	110,633	257,824
Potash, carbonate of	23,263	146,137
Soda, cyanide of	996,979	11,023
Arsenic	259,518	564,191

Exports of chemicals also declined sharply. The value of all chemicals exported during February of 1921 was $5,998,415, as compared with $13,197,994 in February of 1920 and $9,420,043 in January of 1921. The decrease applies through each of the major groups as follows:

	Feb., 1920 Value	Feb., 1921 Value
Acids	$107,564	$141,455
Dyes and dyestuffs	2,461,797	548,420
Extracts for tanning	468,711	82,755
Sodas	1,708,544	437,830

Tungsten in 1920

Not since 1902 has the United States produced so small a quantity of tungsten concentrates as in 1920, according to Frank L. Hess, of the United States Geological Survey, Department of the Interior. The Wolf Tongue Mining Co. and the Vasco Mining Co., of Boulder, Col., were the only American tungsten miners. They produced an equivalent of 216 short tons of ferberite ore carrying 60 per cent tungsten trioxide (WO_3).

Tungsten is most used for making high-speed tools for cutting steel, so that the demand for tungsten ore rises and falls with the steel business. In 1920 the steel business was very dull and the demand for tungsten was correspondingly small. At the same time, in spite of the small demand, the imports were rather large for peace times, and consisted in part of very cheap ore from the shallow placers of China. A good deal of the ore was apparently shipped to this country with the expectation that a heavy duty would be imposed on it and that ores in stock would accordingly increase in value. The imports for 1920 were 1,740 long tons of ore, probably averaging 65 per cent or more tungsten trioxide (WO_3) and were equivalent to about 2,111 short tons of concentrates carrying 60 per cent WO_3. Of this quantity 1,386 short tons of 60 per cent concentrates was shipped from China and most of the rest from South America. Besides the ore 1,997,719 lb. of tungsten and ferrotungsten was imported, equivalent to about 2,250 short tons of 60 per cent ore, and probably more than enough to supply the needs of the high-speed tool industry, so that there was added to the already large stocks in this country somewhat more than the quantity of tungsten represented by the imports of ore.

Exact figures are not at hand, but a large quantity of tungsten ore is in stock in this country, probably more than a three years' supply at the average consumption before the world war.

Armour Research on Nitrides

Prof. Harry McCormack, of the Armour Institute of Technology, spoke before the Chicago Chemists Club on April 12 on "Experiences With a Few Nitrides." Dr. McCormack has been doing research work on nitrides for the past five years, a good deal of his time being devoted to studies with zinc nitrides and aluminum nitrides. While his work on this subject has not been brought to a definite conclusion, a considerable amount of interesting data has been compiled. It is not at all impossible that the manufacture of aluminum nitrides may some day be a commercial process for the fixation of atmospheric nitrogen.

Distillation of Missouri Oaks

The problem of the distillation of Missouri oaks was undertaken in the chemical laboratories of the Missouri School of Mines and Metallurgy to note the yields of products from both the white and black oaks, and to determine the advantage or disadvantage of conducting distillations under reduced pressure. The results of this work were outlined by K. K. Kershner, E. W. Rembert and M. S. Badollet at a meeting of the St. Louis Section of the American Chemical Society, April 8.

The distillations were carried on in a coal-fired, horizontal, cylindrical iron retort, large enough to contain a charge of one-third of a cord of wood. All operations were conducted under good chemical control features and the plant was equipped with adequate condensers and washers. The accompanying table gives the amounts of the various products secured from an average distillation of an 800 lb. charge, running 17 per cent moisture.

DISTILLATION PRODUCTS AND YIELDS

	Normal Pressure White Oak	Normal Pressure Black Oak	Reduced Pressure White Oak	Reduced Pressure Black Oak
Charcoal, lb.	200.0	205.0	245.0	251.0
Gas, cu.ft.	2,910.0	2,785.0	....	....
Pyroligneous acid, lb.	424.0	414.0	463.0	461.0
Tar-coke, lb.	1.5	2.0	2.5	2.6
Tar, dissolved, lb.	14.0	14.4	16.0	20.0
Tar, settled, lb	5.4	8.7	10.0	9.9
Acid, as acetic, lb.	26.7	24.0	30.8	27.7
Acetone, lb.	1.1	1.1	0.8	0.8
Esters, as methyl acetate, lb.	1.7	1.3	0.7	1.5
Methanol, lb.	12.6	15.7	11.3	12.8

The omission of the yield of gas from the reduced pressure distillation is intentional, due to the fact that the suction would occasion an intake of air through every small aperture or leak throughout the entire system.

The greater part of the distillation was conducted under a reduced pressure of 55 to 67 mm. of mercury, a drop to 21 mm. occurring for a short time at the firing point of the charge. The gas ranged from 200 to 500 B.t.u. and gained steadily in amount and heating value as the distillation progressed past the firing point. A general sample of the gas would run about 400 B.t.u. Analysis of gas samples taken every half hour showed that as the distillation progressed there was a drop in carbon dioxide and a gain in unsaturated hydrocarbons, carbon monoxide, methane and hydrogen. There was also a corresponding loss in nitrogen percentage.

About one-third less fuel was required for a reduced pressure distillation as compared with a normal run, although there was a greater tendency for the take-off to become clogged with tar and tar-coke. It was also possible to make a cut containing a higher concentration of desired products in the distillate during a reduced pressure distillation, due to the fact that the greater part of the moisture was removed in the earlier stage of the run.

Obituary

LESTER GRAY FRENCH, prominent in technical journalism and for thirteen years editor and manager of *Mechanical Engineering*, official journal of the American Society of Mechanical Engineers, of which he was assistant secretary, died on April 18 at the French Hospital, New York City, after an operation. Mr. French was born in Keene, N. H., and was graduated from the Massachusetts Institute of Technology in 1891. He began his career as a draughtsman with the Cranston Printing Trust Co. and later was identified with engineering education. In 1897 he became editor-in-chief of *Machinery*, resigning in 1906 to publish technical books. He wrote one of the earliest American treatises on the steam turbine. In 1908 he was made editor of the journal of the American Society of Mechanical Engineers, of which society he was elected a junior in 1899 and a member in 1912. Mr. French was also a member of the Engineers Club of New York.

Personal

John A. Baker, formerly assistant general superintendent for the Mesta Machine Co. of Pittsburgh, Pa., has been appointed works manager for the Los Angeles plant of the Rich Steel Products Co.

Dr. James Bryant Conant, assistant professor of chemistry at Harvard, and Miss Grace Thayer Richards, daughter of Prof. Theodore W. Richards, were married at Cambridge, April 17. The couple intend to travel in Europe during the summer.

José Elorrieta, director of the Forest Service of Vizcaya, Bilbao, Spain, has just completed an extended trip through the United States investigating the forestry of this country. Among other points visited were Chicago and the Forest Products Laboratory at Madison, Wis. He is returning home via Boston.

Harold G. Manning, formerly an assistant examiner in the U. S. Patent Office, and a graduate of the Massachusetts Institute of Technology, has recently opened an office in Waterbury, Conn. Mr. Manning was at one time associated with the law firm of Williams & Pritchard in New York City, and later with the patent department of the Columbia Graphophone Co. of Bridgeport, Conn. While in the Patent Office, he specialized in the examination of electrochemical inventions.

W. C. Peterson, who for the past twelve years has been associated with the Packard Motor Car Co., in charge of its metallurgical laboratories, has been placed in charge of the metallurgical department of the Atlas Crucible Steel Co.'s mills at Dunkirk, N. Y. Mr. Peterson's work at the Atlas will include research and standardization of the new chromium-molybdenum products which have already been introduced to alloy steel purchasers of the country.

George B. Troxell, who has been connected with the Bethlehem Steel Co., Bethlehem, Pa., for the past five years, resigned as assistant superintendent of the electric furnace and crucible departments. He is considering a South American project.

U. C. Young, formerly plant engineer with the Provident Chemical Works of St. Louis, has severed his connection and is now manager of the chemical works of the Calumet Baking Powder Co., Joliet, Ill.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, April 25, 1921.

Trading in heavy chemicals has shown little change during the past week and has been limited to comparatively small lots. Consumers still lack confidence and show no interest beyond their immediate necessities, in spite of offers of material at extremely low prices by holders. Prospective tariff changes are awaited with keen interest and in general enough uncertainty surrounds the chemical industry to warrant the conservative policy that is so manifest.

Manufacturers of chemicals are not discontented over business conditions. Sales cannot be compared with last year at this time, but the demand has shown a marked improvement compared with the first few months of this year. *Soda ash* is in strong demand for consuming wants. Glass, textile and soap plants are taking this chemical in moderate volume. Solid *caustic soda* is being well maintained in first hands. Export inquiries from South America are reaching the market quite frequently. *Bleaching powder* is moving in fair dimensions for domestic consumption. *Bichromate of soda* has shown a decided improvement, with small lot sales predominating. Foreign *muriate of potash* and *prussiate of soda* have remained fairly steady. Imported *caustic potash* has attracted a little attention on account of the relatively low prices prevailing. Leading producers, on the other hand, have reduced prices on *sal ammoniac, glaubers salt, sulphite of soda* and *hyposulphite of soda*. *Arsenic, copper sulphate* and other chemicals used for agricultural purposes are not finding an open market. Farmers are not disposed to take much interest in their products when agricultural commodities are selling at the lowest level since the war.

In general, it may be stated that the chemical industry is undergoing a slow development. Slow business usually causes irregularity, but the basic conditions are making for a gradual improvement. The reduction in wage scales and in prices of finished products have been accomplished with very little difficulty.

General Chemicals

Spot *bichromate of soda* closed firm with most sellers asking as high as 7¾c. per lb. Sales were reported for small lots at this figure. The market looked tight, and while it was admitted that a moderate amount of stock is being held by dealers, there is no apparent disposition to release offerings at prevailing prices. Light sales of *caustic soda* were reported at $3.65@$3.70 per 100 lb. ex-store N. Y. It is probable that $3.60 can be done in some directions, although cheap offerings of standard brands have been well cleared from the market. Producers' prices are unchanged at former levels. Demand did not show any unusual activity so far as resale goods are concerned, although manufacturers did a fair business for prompt and future shipments. Resale light *soda ash* is scarce and prices are higher. Prominent sellers ask up to $2.10 for single bags in carload lots on spot. Double bags are not plentiful and are held at $2.20 per 100 lb. f.a.s. steamer. Barrels are moving at $2.30@$2.35. The demand is quite steady. Producers' contracts are unchanged at $1.72½, basis 48 per cent, in carload lots for single bags f.o.b. works. Imported *prussiate of soda* has not shown any noticeable strength during the week and the market has been kept unsettled through the keen competition of holders. The range extended from 11½@12c. per lb. during most of the period, but at the close it was reported that 11¼c. would probably be accepted by some sellers on a firm bid. Moderate quantities of resale solid *sodium sulphide*, 60-62 per cent, are being offered by second hands at 5½c. per lb. and some business is reported at this level. The broken variety is quite scarce and is held firmly at 6½c. The War Board has placed *nitrite of soda* on the list of restricted imports and it is possible that this might force prices up around producers' costs. Stocks around town are known to be quite heavy with offerings for spot material as low as 5½c. per lb. Norwegian nitrite could not be had for less than 10c. per lb. for shipment.

Consumers of *arsenic* are reported to be well supplied with this chemical at present and the market presented a quiet appearance. Resale lots have reached the market during the week at 7¾@8½c. per lb. Leading producers are holding shipments at 8½c. The fact that agricultural material has declined is said to be responsible for the lack of inquiry from manufacturers of insecticides. Spot *barium chloride* is held at $60 per ton. The market is still considerably above pre-war figures and buyers are operating on a conservative basis. Imports of *magnesium sulphate* have been very heavy during the past week, but there was very little change noted in quoted prices. Commercial imported sulphate is quoted at $1.40 per 100 lb. as against $2.20 named by domestic makers. Prices on *caustic potash* are very uncertain in the absence of any demand. Domestic makers are quoting prices far above the spot market. Imported caustic is very weak at 8c. per lb. and resale American material is quoted down to 7@7½c. per lb. Resale prices for *formaldehyde* range from 13@14½c. per lb., dealers naming about 13¾c. Producers are asking 15@15½c., but might consider lower prices on a firm offer. Producers of *tin oxide* report small sales on the basis of 40c. per lb. Occasional trading in resale lots has gone

through at 39c. Demand has not shown much activity, but offerings are not heavy and the tone appears quite firm.

COAL-TAR PRODUCTS

Trading in intermediates has been entirely without new developments. Prices have been soft in all quarters, with the consuming demand at a very low ebb. A great deal of uncertain feeling that has hung over the market for so long a period is disappearing, however, and the views in producing circles are of a much more optimistic nature, since the intentions of Washington authorities are now more clearly in favor of protection. Conditions in many of the textile mills have shown progressive development. Interest in intermediates and dyestuffs for furs has been fairly active, in view of the business now developing through fur auctions in New York, and *para amidophenol* reflected a steady tendency. The silk mills reported a fair amount of orders from retail quarters. There has been no material change in intermediates, except that distressed lots of *aniline oil* were heard on the market at 18c. per lb. The demand for *beta naphthol* was practically unchanged, although resale material has not been plentiful of late. Prices are quoted at 40@45c. per lb. by makers, while resale lots are held at 32@34c. Prices on *para nitraniline* are still very uncertain, with quotations over a range of 85c.@$1.05 per lb.

The *naphthalene* market continued dull, with resale material still to be had in sufficient quantity to meet all present requirements. Prices in the resale market for flakes are around 8c. per lb. The refiners of naphthalene are asking 8½@9½c. for the flake and 9½@10½c. for the balls, depending on quantity. Business with the fur trade has been fair, but is showing signs of slowing up. *Benzene* producers continue to control supplies and are holding prices firm at former levels, in spite of the lack of interest from consumers. Business, however, is showing some signs of improvement with orders coming in more regularly. There has been very little activity in the market for *aniline salt.* Supplies are available in most quarters and while prices are quotably unchanged at 26@29c. per lb., a firm order would probably induce holders to shade.

The Chicago Market

CHICAGO, April 23, 1921.

There were few developments of noteworthy character in the market for industrial chemicals during the past week. Consumers are still averse to purchasing beyond their immediate needs and business was of the same hand-to-mouth character that has been noted for some time past. The prevailing tone was easy and many products were obtainable at lower prices. *Soda ash* is easier at 2¾c. per lb. in small quantities. There are no new developments in *caustic soda*, the market being steady with the offerings light for prompt and nearby delivery. The solid is quoted around $4.10 per 100 lb. and the ground at $4.75 in ton lots. *Aluminum sulphate*, iron free, is very quiet, there being little or no demand from the consuming trade. This material is offered on spot at from 3¼@4c. per lb., depending upon the quantity. *Ammonium chloride*, white gran., is lower, and is offered in some quarters at 9c. for single barrels. Consumers think this price is still too high and are waiting for further breaks.

Methanol showed no further decline, although the inquiry is light. Second hands are asking 80c. per gal. for the 95 per cent in drums and 85c. for the 97 per cent. There is little or no request for *barium chloride* and the price is unchanged at $75@$80 per ton. *Barium peroxide* is also very quiet and is offered at 18c. per lb. There is an ample supply of *carbon tetrachloride* available at 11c. for large drums. Holders show no disposition to shade this price, some factors believing that the market will react soon and that they will be able to obtain higher prices. *Iron sulphate* is in fair demand and is quoted at 1¾@2¼c., according to the package. Calcined *carbonate of potash*, 80-85 per cent, is easy, and is offered freely at 11c. in cask lots. The continued arrival of cheap foreign material is weakening the market and lower prices are expected. *Caustic potash* is stagnant, with second hands in control of the

market. They are offering 88-92 per cent material of foreign origin at 8@8½c. per lb., while large business would probably bring out even better prices. Resale lots of *bichromate of potash* are available at 14½c. per lb. in casks. *Bichromate of soda* is steadier; 9c. per lb. for spot material seems to be the best offer, while some factors have advanced their ideas to 9½c. Dry powdered *sodium bisulphite* is slowly getting back to normal and is available at 6@6¾c., according to the holder. *Sodium bicarbonate* of standard brands is offered at 2½c. per lb. for less than carlots. There are reports from some quarters that a fair volume of business is done at these figures.

Permanganate of potash is lower, U.S.P. material of domestic manufacture being now available at 39c. per lb. This price is still far from the pre-war level and with the low-priced foreign material coming in lower prices can be expected. C.p. *glycerine* has been reduced by refiners to 16½c. per lb. in large or small drums. This marks the lowest level reached in over ten years and can hardly be expected to go much lower.

In general, there is little change in the list of acids. *Acetic, glacial,* is maintained at 11c. per lb. and the 28 per cent commercial at 2¾@3c. per lb. *Hydrochloric,* 18 deg., is steady at 2@3c. per lb. in carboys, price depending upon the quantity. *Sulphuric* is unchanged at $19@$20 per ton in tank cars and 2@3c. in carboys. *Nitric* is asked for in small quantities and is quoted in carboys at 8½@9c. per lb.

VEGETABLE OILS

Unusually quiet conditions still prevail in the vegetable oils trade. *Linseed oil* is freely offered at 60c. per gal. in barrels for the raw and 62c. for the boiled. There is little demand from the consuming trade and there is some talk of further reductions. *Corn oil* is in small demand and is offered at 10@11c. per lb. The inquiry for *coconut oil* has improved somewhat, and the price remains unchanged at 10@10½c. per lb.

NAVAL STORES

There were several substantial price advances reported in the local market for naval stores. The leading dealers have advanced the price on *spirits of turpentine*, which is now generally quoted at 65c. per gal. in barrels. Business in *rosins* is slightly more active, the WG grade now being quoted at $7.75@$8 per 280 lb. *Rosin oil* is firm at 55c. per gal. in barrels.

COAL-TAR PRODUCTS

There were no developments to speak of in coal-tar products, and, in general, prices are unchanged. *Benzene* is quiet, the prevailing quotations being 28@31c. per gal. for the 90 per cent, and 30@33c. for the pure. Refined *toluene* is unchanged and an ample supply is available at 33c. per gal. in drums. There is a slight movement of *naphthalene flakes*, with most holders asking 8½@10c., according to the size package.

The Iron and Steel Market

PITTSBURGH, April 22, 1921.

Price readjustment in the steel market is now practically complete, and practically the whole market is now on a uniform basis as between the Steel Corporation and the independents. Prospects are that the market will remain on this equalized and stabilized basis for some time to come, possibly through the summer. The Steel Corporation has no incentive to reduce its new prices, as it has absorbed a great deal since the Industrial Board settlement of March 21, 1919, including the absorption of the wage advance of Feb. 1, 1920, the freight rate advance of Aug. 26, 1920, and the present price reductions, all without reducing wages.

The market is now quotable steady all along the line as follows: Billets, $37; slabs, $38; sheet bars and small billets, $39; forging billets, $42; rods, $48; merchant bars, 2.10c.; shapes, 2.20c.; plates, 2.20c.; hoops, 2.75c.; blue annealed sheets, 3.10c.; black sheets, 4c.; galvanized sheets, 5c.; tin plate, $6.25; plain wire, 3c.; wire nails, $3.25; standard steel pipe, 62½ per cent basing discount.

New seamless tube prices have been announced by the

National Tube Co., representing a reduction of about $20 a ton from the Industrial Board schedule. At the same time there is a reversion to the system of quoting discounts from list, the Government price control having started a new system, that of quoting per net ton. Discounts are: 1-in., 56 per cent; 1¼-in., 49 per cent; 1½-in., 48 per cent; 1¾-in., 25 per cent; 2 to 2½-in., 17½ per cent; 2¾ to 4-in., 20 per cent; 4½ and 5-in., 7½ per cent, on cold-finished seamless tubes.

MANUFACTURED PRODUCTS

New prices have been made by steel mills or others on various manufactured steel products, and the following prices may now be quoted: Standard railroad spikes, 3.30c.; ½-, ⁷⁄₁₆- and ⅝-in., 3.65c.; ⁹⁄₁₆-in., 4.25c.; boat and barge spikes, 3.85c.; track bolts, 4.50c.; chain, 6.35c., base, for 1-in. proof coil; button-head structural rivets, 3.50c.; cone-head boiler rivets, 3.60c.; cold-finished steel bars, 3.10c.; cold-rolled strip, 5.50c.

Prices of manufactured steel products in general show larger percentage spreads above the mill prices of the hot-rolled material from which they are made than obtained before the war. Thus, if the disposition of the ultimate consumer to make purchases is to be gaged by the price, which usually is not precisely the case, comparison should be made of the prices of the manufactured products rather than of the mill prices for the intermediate material. For illustration, comparing present prices with average prices in the five years 1909 to 1913 inclusive, bars at 2.10c. are up 58 per cent, while standard railroad spikes at 3.30c. are up 104 per cent.

BUYING LIGHT

New buying in steel products has been very light since the market got on the stabilized and equalized basis. It is understood that the independents gathered up a very fair volume of business as they were withdrawing their extreme prices, as of course they were willing to accept orders if the buyer would act at once. This will probably give the independents a better operation for the next two or three weeks than they have had. Their average rate early in April was about 35 per cent of capacity, against about 32 per cent in March and 30 per cent in February and January.

The Steel Corporation is receiving slightly more business than formerly in releases against suspended orders and in specifications against old contracts, now that it has reduced its prices, as of course the reduction applies to unexecuted obligations. Last week and this the corporation's operations as a whole have averaged about 40 per cent of capacity or a shade less, there having been a continued decline from the rate of 90 per cent shown for January. Corporation operations have probably rounded the turn, and may mount to 50 per cent within a few weeks.

PIG IRON AND COKE

The pig iron market continues to exhibit an almost complete apathy on the part of buyers. Indeed, the only inquiry of any consequence for any grade is a single inquiry for 10,000 tons of basic, for the United Alloy Steel Co., Canton, Ohio, and doubts are entertained whether any considerable tonnage will really be bought at this time against the inquiry. The market remains quotable at prices formerly developed, $25 for bessemer, foundry and malleable and $23 for basic, f.o.b. valley furnaces, freight to Pittsburgh being $1.96. Consumption of merchant iron is at a very low rate and production is at a still lower rate, but there are stocks of considerable magnitude in the aggregate still to be absorbed before the market is equalized as between the buying power of the consumer and the production cost of the merchant furnaces. The furnaces can now have no complaint as to the cost of coke, in this general matter of deflation of costs and selling prices, since recent sales of Connellsville furnace coke at $3.50 have been followed by some small sales at $3.30 per net ton at ovens. The high freight rates remain, putting a great burden on furnaces in assembling about four tons of material per ton of pig iron made.

General Chemicals
CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots		Less Carlots	
Acetic anhydride	lb.	–		$0.40 –	$0.45
Acetone	lb.	$0.13 –	$0.13½	1½ –	.14
Acid, acetic, 28 per cent	100 lbs.	2.50 –	2.75	3.00 –	3.25
Acetic, 56 per cent	100 lbs.	4.00 –	4.25	4.50 –	5.50
Acetic, glacial, 99½ per cent, carboys	100 lbs.	9.50 –	9.75	10.00 –	10.50
Boric, crystals	lb.	.13½ –	.14	.14½ –	.15
Boric, powder	lb.	.15 –	.15½	.16 –	.16½
Citric	lb.	–		47 –	50
Hydrochloric	100 lb.	1.50 –	1.65	1.75 –	2.00
Hydrofluoric, 52 per cent	lb.	.13 –	.13½	.14 –	.14½
Lactic, 44 per cent tech	lb.	.10 –	.11	.11½ –	.12
Lactic, 22 per cent tech	lb.	.04½ –	.05½	.06 –	.07
Molybdic, C. P.	lb.	4.00 –	4.50	4.50 –	5.00
Muriatic, 20 deg. (see hydrochloric)					
Nitric, 40 deg	lb.	.06¼ –	.06½	.07 –	.07½
Nitric, 42 deg	lb.	.07½ –	.07½	.07½ –	.08½
Oxalic, crystals	lb.	.17 –	.18	.18½ –	.20
Phosphoric, Ortho, 50 per cent solution	lb.	.17 –	.17½	.18 –	.19
Picric	lb.	.30 –	.32	.35 –	.40
Pyrogallic, resublimed	lb.	–		1.90 –	2.15
Sulphuric, 60 deg., tank cars	ton	–			
Sulphuric, 60 deg., drums	ton	–		14.00 –	15.00
Sulphuric, 66 deg., tank cars	ton	19.00 –	20.00		
Sulphuric, 66 deg., drums	ton	22.00 –	22.50	23.00 –	23.50
Sulphuric, 66 deg., carboys	ton	–			
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 –	24.00	–	
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 –	26.00	26.50 –	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 –	35.00	40.00 –	
Tannic, U. S. P.	lb.	–		1.00 –	1.10
Tannic (tech.)	lb.	.50 –	.52	.54 –	.57
Tartaric, crystals	lb.	–		.35 –	.39
Tungstic, per lb. of WO	lb.	–		1.30 –	1.40
Alcohol, Ethyl	gal.	–		4.90 –	5.25
Alcohol, Methyl (see methanol)					
Alcohol, denatured, 188 proof	gal.	–		.36 –	.40
Alcohol, denatured, 190 proof	gal.	–		.40 –	.45
Alum, ammonia lump	lb.	.04 –	.04½	.04½ –	.04½
Alum, potash lump	lb.	.05 –	.05½	.05½ –	.06½
Alum, chrome lump	lb.	.13 –	.13½	.14 –	.14½
Aluminum sulphate, commercial	lb.	.02½ –	.02½	.03 –	.03½
Aluminum sulphate, iron free	lb.	.03½ –	.03½	.03½ –	.04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 –	.07½	.07½ –	.08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 –	.32	.33 –	.35
Ammonium carbonate, powder	lb.	.07½ –	.08	.08½ –	.10
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.06¼ –	.06½	.07 –	.07½
Ammonium chloride, granular (gray sal-ammoniac)	lb.	.08½ –	.08½	.09 –	.09½
Ammonium nitrate	lb.	.08 –	.08½	.09 –	.10
Ammonium sulphate	100 lb.	2.75 –	2.85	2.90 –	3.00
Amylacetate	gal.	–		4.00 –	4.25
Amylacetate tech	gal.	–		3.00 –	3.25
Arsenic oxide, (white arsenic) powdered	lb.	.07½ –	.08	.08½ –	.09
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 –	.12½	.13 –	.14
Barium chloride	ton	60.00 –	65.00	70.00 –	75.00
Barium dioxide (peroxide)	lb.	.19 –	.20	.21 –	.22
Barium nitrate	lb.	.11 –	.11½	.12 –	.12½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ –	.05	.05½ –	.06
Bleaching powder (see calc. hypochlorite)					
Blue vitriol (see copper sulphate)					
Borax (see sodium borate)					
Brimstone (see sulphur, roll)					
Bromine	lb.	.40 –	.41	.42 –	.45
Calcium acetate	100 lbs.	1.75 –	2.00	–	
Calcium carbide	lb.	.04½ –	.04½	.05 –	.05½
Calcium chloride, fused, lump	ton	27.00 –	29.00	30.00 –	32.00
Calcium chloride, granulated	lb.	.01½ –	.01½	.02 –	.02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.55 –	2.65	2.75 –	3.00
Calcium peroxide	lb.	–		1.25 –	1.50
Calcium phosphate, tribasic	lb.	–		.15 –	.16
Camphor	lb.	–		.63 –	.65
Carbon bisulphide	lb.	.07 –	.07½	.07 –	.08
Carbon tetrachloride, drums	lb.	.10 –	.10½	.11 –	.12
Carbonyl chloride (phosgene)	lb.	–		.75 –	1.00
Caustic potash (see potassium hydroxide)					
Caustic soda (see sodium hydroxide)					
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 –	.09	.09½ –	.10
Chloroform	lb.	–		.38 –	.40
Cobalt oxide	lb.	–		3.00 –	3.10
Copperas (see iron sulphate)					
Copper carbonate, green precipitate	lb.	.23 –	.24	.25 –	.27
Copper cyanide	lb.	–		.50 –	.62
Copper sulphate, crystals	lb.	.05½ –	.05½	.06 –	.06½
Cream of tartar (see potassium bitartrate)					
Epsom salt (see magnesium sulphate)					
Ethyl Acetate Com. 85%	gal.	–		.90 –	1.00
Ethyl Acetate pure (acetic ether 98% to 100%)		–		–	
Formaldehyde, 40 per cent	lb.	.14 –	.14½	.14½ –	.15
Fusel oil, ref	gal.	–		3.25 –	3.50
Fusel oil, crude	gal.	–		1.75 –	2.00
Glauber's salt (see sodium sulphate)					
Glycerine, C. P. drums extra	lb.	–		.16½ –	.17½
Iodine, resublimed	lb.	–		3.75 –	3.85
Iron oxide, red	lb.	–		.10 –	.20
Iron sulphate (copperas)	100 lb.	.75 –	1.00	1.10 –	1.25
Lead acetate	lb.	–		.11½ –	.13
Lead arsenate, paste	lb.	.08½ –	.09	.09½ –	.10
Lead nitrate	lb.	–		.15 –	.20
Litharge	lb.	.08½ –	.09	.09½ –	.10
Lithium carbonate	lb.	–		1.25 –	
Magnesium carbonate, technical	lb.	.10½ –	.11	.11½ –	.12
Magnesium sulphate, U. S. P.	100 lb.	2.75 –	3.00	–	
Magnesium sulphate, technical	100 lb.	–		1.40 –	2.25
Methanol, 95%	gal.	–		.75 –	.77
Methanol, 97%	gal.	–		.78 –	.82
Nickel salt, double	lb.	–		.13 –	.17½
Nickel salt, single	lb.	–		.14 –	.14½
Phosgene (see carbonyl chloride)					
Phosphorus, red	lb.	.45 –	.46	.47 –	.50
Phosphorus, yellow	lb.	–		.35 –	.37
Potassium bichromate	lb.	.12 –	.12½	.12½ –	.13

Item	Unit	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ ... - $	$0.30 - $0.35
Potassium bromide, granular	lb.		.20 - .40
Potassium carbonate, U. S. P.	lb.	.35 - .40	.45 - .50
P.tassium carbonate, crude	lb.	.06½ - .07	.08 - .09
P.tassium chlorate, crystals	lb.	.08 - .09	.10 - .14
Porassium cyanide	lb.		.32 - .35
Potassium hydroxide (caustic potash)	lb.	.07 - .07½	.08 - .10
Potassium muriate	ton	52.00 - 55.00	
Potassium iodide	lb.		2.75 - 3.00
Potassium nitrate	lb.	.09½ - .09½	.10 - .12½
Potassium permanganate	lb.	.35 - .37	.39 - .40
Potassium prussiate, red	lb.	.35 - .37	.38 - .40
Potassium prussiate, yellow	lb.	.26 - .27	.28 - .29
Potassium sulphate (powdered)	per unit		1.75 - 1.80
Rochelle salts (see sodium potas. tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton		33.00 - 35.00
Silver cyanide	oz.		1.30 - 1.35
Silver nitrate	oz.		.39 - .40
Soda ash, light	100 lb.	2.10 - 2.20	2.25 - 2.50
Soda ash, dense	100 lb.	2.35 - 2.40	2.50 - 2.60
Sodium acetate	lb.	.04½ - .05	.05½ - .06
Sodium bicarbonate	100 lb.	2.50 - 2.60	2.70 - 3.00
Sodium bichromate	lb.	.07½ - .08	.08½ - .08½
Sodium bisulphate (nitre cake)	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05½ - .05½	.05½ - .06'
Sodium borate (borax)	lb.	.06½ - .06½	.07 - .07½
Sodium carbonate (sal soda)	100 lb.	1.90 - 2.00	2.25 - 2.50
Sodium chlorate	lb.	.08½ - .09	.09½ - .10
Sodium cyanide, 96-98 per cent	lb.	.19 - .20	.21 - .30
Sodium fluoride	lb.	.12 - .12½	.13 - .14
Sodium hydroxide (caustic soda)	100 lb.	3.65 - 3.75	3.80 - 4.00
Sodium hyposulphite	l?		.03½ - .04
Sodium nitrate	100 lb.	2.60 -	2.75 -
Sodium nitrite	lb.	.05½ - .06	.06½ - .07
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04½ - .04½	.05 - .05½
Sodium potassium tartrate (Rochelle salts)	lb.		.27 - .28
Sodium prussiate, yellow	lb.	.11½ - .11½	.12 - .12½
Sodium silicate, solution (40 deg.)	lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.03½ - .03½
Sodium sulphate, crystals(Glauber's salt)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide,fused,60-62 per cent(conc.)	lb.	.05½ - .05½	.06 - .06½
Sodium sulphite, crystals	lb.	.03½ - .04	.04½ - .04½
Strontium nitrate, powdered	lb.	.16 - .16½	.17 - .18
Sulphur chloride, red	lb.	.07½ - .07½	.07½ - .08
Sulphur, crude	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.40 - .42
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran	lb.	.11 - .11½	.11½ - .12
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13½ - .14
Zinc oxide, XX	lb.	.08½ - .09	.09½ - .10
Zinc sulphate	lb.	.03½ - .03½	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Item	Unit	Carlots	Less Carlots
Alpha-naphthol, crude	lb.	$1.15 - $1.25	
Alpha-naphthol, refined	lb.	1.45 - 1.50	
Alpha-naphthylamine	lb.	.38 - .40	
Aniline oil, drums extra	lb.	.19 - .26	
Aniline salts	lb.	.26 - .29	
Anthracene, 80%, in drums (100 lb.)	lb.	.75 - 1.00	
Benzaldehyde U.S.P.	lb.	1.00 - 1.50	
Benzidine, base	lb.	.90 - 1.00	
Benzidine sulphate	lb.	.75 - .80	
Benzoic acid, U.S.P.	lb.	.65 - .70	
Benzoate of soda, U.S.P.	lb.	.65 - .70	
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 - .32	
Benzene, 90%, in drums (100 gal.)	gal.	.25 - .28	
Benzyl chloride, 95-97%, refined	lb.	.28 - .30	
Benzyl chloride, tech.	lb.	.25 - .27	
Beta-naphthol benzoate	lb.	3.50 - 4.00	
Beta-naphthol, sublimed	lb.	.70 - .75	
Beta-naphthol, tech.	lb.	.33 - .45	
Beta-naphthylamine, sublimed	lb.	2.25 - 2.40	
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18	
Ortho-cresol, in drums (100 lb.)	lb.	.25 - .27	
Cresylic acid, 97-99%, straw color, in drums	gal.	.90 - .95	
Cresylic acid, 75-97%, dark, in drums	gal.	.85 - .90	
Cresylic acid, 50%, first quality, drums	gal.	.55 - .60	
Dichlorbenzene	lb.	.06 - .09	
Diethylaniline	lb.	1.20 - 1.25	
Dimethylaniline	lb.	.48 - .55	
Dinitrobenzene	lb.	.32 - .35	
Dinitrochlorbenzene	lb.	.20 - .30	
Dinitronaphthalene	lb.	.30 - .40	
Dinitrophenol	lb.	.35 - .40	
Dinitrotoluene	lb.	.25 - .27	
Dip oil, 25%, tar acids, car lots, in drums	gal.	.40 - .45	
Diphenylamine	lb.	.60 - .70	
H-acid	lb.	1.30 - 1.50	
Meta-phenylenediamine	lb.	1.20 - 1.25	
Monochlorbenzene	lb.	.14 - .16	
Monoethylaniline	lb.	1.75 - 1.85	
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 - .08½	
Naphthalene, flake	lb.	.08½ - .09½	
Naphthalene, balls	lb.	.09½ - .10½	
Naphthionic acid, crude	lb.	.70 - .75	
Nitrobenzene	lb.	.12 - .15	
Nitro-naphthalene	lb.	.30 - .35	
Nitro-toluene	lb.	.16 - .18	
Ortho-amidophenol	lb.	3.20 - 3.75	
Ortho-dichlor-benzene	lb.	.15 - .20	
Ortho-nitro-phenol	lb.	.75 - .80	
Ortho-nitro-toluene	lb.	.17 - .20	
Ortho-toluidine	lb.	.20 - .25	
Para-amidophenol, base	lb.	1.75 - 1.85	
Para-amidophenol, HCl	lb.	2.00 - 2.10	

Item	Unit	Carlots	Less Carlots
Para-dichlorbenzene	lb.	.15 - .20	
Paranitroaniline	lb.	.90 - 1.05	
Para-nitrotoluene	lb.	.85 - 1.00	
Para-phenylenediamine	lb.	1.95 - 2.00	
Para-toluidine	lb.	1.25 - 1.60	
Phthalic anhydride	lb.	.50 - .60	
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.11 - .13	
Pyridine	gal.	2.00 - 3.50	
Resorcinol, technical	lb.	1.75 - 1.85	
Resorcinol, pure	lb.	2.25 - 2.30	
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22 - .23	
Salicylic acid, U. S. P.	lb.	.21 - .22	
Salol	lb.	.85 - .95	
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 - .28	
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 - .16	
Sulphanilic acid, crude	lb.	.30 - .35	
Tolidine	lb.	1.35 - 1.45	
Toluidine, mixed	lb.	.40 - .45	
Toluene, in tank cars	gal.	.25 - .28	
Toluene, in drums	gal.	.28 - .31	
Xylidines, drums, 100 gal.	lb.	.40 - .45	
Xylene, pure, in drums	gal.	.42 - .45	
Xylene, pure, in tank cars	gal.	.45 -	
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35	
Xylene, commercial, in tank cars	gal.	.30 -	

Waxes

Prices based on original packages in large quantities.

Item	Unit		
Beeswax, refined, dark	lb.	$0.23 - $0.25	
Beeswax, refined, light	lb.	.25 - .27	
Beeswax, white pure	lb.	.40 - .45	
Carnauba, Flora	lb.	.66 - .68	
Carnauba, No. 2, North Country	lb.	.30 - .32	
Carnauba, No. 3, North Country	lb.	.18 - .19	
Japan	lb.	.18½ - .19½	
Montan, crude	lb.	.07 - .08	
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04 -	
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03½ -	
Paraffine waxes, refined, 118-120 m.p.	lb.	.04 - .04½	
Paraffine waxes, refined, 125 m.p.	lb.	.04½ - .04½	
Paraffine waxes, refined, 128-130 m.p.	lb.	.05½ - .06	
Paraffine waxes, refined, 133-135 m.p.	lb.	.06 - .06½	
Paraffine waxes, refined, 135-137 m.p.	lb.	.06½ - .06½	
Stearic acid, single pressed	lb.	.11 -	
Stearic acid, double pressed	lb.	.11½ -	
Stearic acid, triple pressed	lb.	.12 - .12½	

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Item	Unit		
Rosin B-D, bbl.	280 lb.	$5.00 -	
Rosin E-I	280 lb.	5.25 -	
Rosin K-N	280 lb.	5.75 -	
Rosin W. G.-W. W.	280 lb.	6.25 -	
Wood rosin, bbl.	280 lb.	6.25 -	
Spirits of turpentine	gal.	.63 -	
Wood turpentine steam dist.	gal.	.62 -	
Wood turpentine, dest. dist.	gal.	.60 -	
Pine tar pitch, bbl.	200 lb.		7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.		13.00
Retort tar, bbl.	500 lb.	13.00 -	13.00
Rosin oil, first run	gal.	.40 -	
Rosin oil, second run	gal.	.43 -	
Rosin oil, third run	gal.	.45 -	
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.		$1.70
Pine oil, pure, dest. dist.	gal.		1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.48
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.		.36
Turpentine, crude, sp.gr., 0.900-0.970	gal.		1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.37
Pinewood creosote, ref	gal.		.55

Solvents

Item	Unit	
73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Item	Unit		
Para—Upriver fine	lb.	$0.17 - $0.18	
Upriver coarse	lb.	.11½ - .12½	
Upriver caucho ball	lb.	.14 - .14½	
Plantation—First latex crepe	lb.	.18½ -	
Ribbed smoked sheets	lb.	.16½ -	
Brown crepe, thin, clean	lb.	.18 -	
Amber crepe No. 1	lb.	.20 -	

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Item	Unit		
Castor oil, No. 3, in bbls.	lb.	$0.08½ - $0.09½	
Castor oil, AA, in bbls.	lb.	.09½ - .10	
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.09½ - .09½	
Cocoanut oil, Ceylon grade, in bbls.	lb.	.10 - .10½	
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½ - .11	
Corn oil, crude, in bbls.	lb.	.07½ - .08	
Cottonseed oil, crude (f. o. b. mill)	lb.	.04½ - .04½	
Cottonseed oil, summer yellow	lb.	.06½ - .06½	
Cottonseed oil, winter yellow	lb.	.07 -	
Linseed oil, raw, car lots (domestic)	gal.	.60 - .61	
Linseed oil, raw, tank cars (domestic)	gal.	.53 -	
Linseed oil, in 5-bbl lots (domestic)	gal.	.63 - .65	

Olive oil, Denatured	gal.	$1.40 —	$1.70
Palm, Lagos	lb.	.07 —	.07½
Palm, Niger	lb.	.05½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.05½ —	.05½
Peanut oil, refined, in bbls.	lb.	.10 —	.10½
Rapeseed oil, refined in bbls.	gal.	.88 —	.90
Rapeseed oil, blown, in bbls.	gal.	1.00 —	1.05
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07½ —	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.04½ —	....

FISH

Light pressed menhaden	gal.	$0.42 —	$0.43
Yellow bleached menhaden	gal.	.45 —	....
White bleached menhaden	gal.	.48 —	....
Blown menhaden	gal.	.80 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00 —	17.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.07
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Fla.	net ton	15.00 —	25.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.07½ —	.08
Graphite, Ceylon chip	lb.	.06 —	.06½
Graphite, high grade amorphous crude	lb.	.02½ —	.03
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.57 —	....
Shellac, orange superfine	lb.	.60 —	....
Shellac, A. C. garnet	lb.	.45 —	....
Shellac, T. N.	lb.	.45 —	....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	14.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	35.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000		160
Carborundum refractory brick, 9-in. { less than carlot	1,000		1250.00
{ carload lots	1,000		1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		80–100
Chrome cement, 40–45% Cr₂O₃	net ton		45–50
Chrome cement, 40–45% Cr₂O₃, sacks, in car lots, f.o.b. Eastern shipping points	net ton		55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		55–60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		45–50
Magnesite brick, 9-in. straight	net ton		90
Magnesite brick, 9-in. arches, wedges and keys	net ton		105
Magnesite brick, soaps and splits	net ton		120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000		45–55
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		45–55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000		45–55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.15 —	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	85.00 —	90.00
Ferromanganese, 76-80% Mn, English	gross ton	85.00 —	90.00
Spiegeleisen, 18-22% Mn	gross ton	32.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	80.00 —	85.00
Ferrosilicon, 75%	gross ton	145.00 —	150.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40%, per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr₂O₃	unit	.45 —	.50
Chrome ore, 50% Cr₂O₃, f.o.b. Atlantic seaboard	unit	.45 —	.50
Coke, foundry, f.o.b. ovens	net ton	4.50 —	5.50
Coke, furnace, f.o.b. ovens	net ton	3.50 —	4.25
Coke, petroleum, refinery, Atlantic seaboard	net ton	15.00 —	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico	net ton	17.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.50
Ilmenite, 52% TiO₂, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.30 —	.35
Manganese ore, chemical (MnO₂)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS₂, per lb. of MoS₂, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO₂, c.i.f. Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14 —	.15
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14 —	.15
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.12 —	.13
Rutile, 95% TiO₂, per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO₃ and over, per unit of WO₃ (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO₃ and over, per unit of WO₃, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U₃O₈	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U₃O₈	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V₂O₅ contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	28.0 @ 28.5
Antimony, wholesale lots, Chinese and Japanese	5¼ @ 5½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	.35
Monel metal ingots	.38
Monel metal, sheet bars	.40
Tin, 5-ton lots, Straits	30.75
Lead, New York, spot	4.25 @ 4.35
Lead, E. St. Louis, spot	4.20
Zinc, spot, New York	5.10
Zinc, spot, E. St. Louis	4.60

OTHER METALS

Silver (commercial)	oz.	$0.60½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.50 @ 1.65
Cobalt	lb.	4.00
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00–75.00
Iridium	oz.	250.00 @ 300.00
Palladium	oz.	65.00 @ 70.00
Mercury	75 lb.	44.00–45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50–20.75
Copper bottoms	28.00–28.25
Copper rods	19.25–20.00
High brass wire	18.25
High brass rods	15.25
Low brass wire	20.25
Low brass rods	20.25
Brazed brass tubing	29.00
Brazed bronze tubing	34.25
Seamless copper tubing	22.00
Seamless high brass tubing	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	8.50 @ 9.00	18.50	10.00	10.50
Copper, heavy and wire	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy	3.25 @ 3.50	7.25	4.00	4.00
Lead, tea	2.15 @ 2.30	5.25	3.00	3.00
Brass, heavy	4.25 @ 4.50	9.50	7.00	10.00
Brass, light	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings	4.00 @ 4.25	9.50	5.50	6.00
Zinc	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are f or structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.50	$3.23	$3.23
Soft steel bars	2.50	3.00	3.13
Soft steel bar shapes	2.50	3.13	3.13
Soft steel bands	2.85	3.83	3.83
Plates, ¼ to 1 in. thick	2.50	3.30	3.30

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Arkansas Producing & Refining Co., Gazette Bldg., has plans under way for the erection of a new oil refinery in the vicinity of El Dorado, Ark., to have an initial capacity of about 3,000 bbl. The plant will comprise a large tankage system, both for run-down and storage service, with pipe lines extending to the company's wells, about 5 miles distant. The new plant is estimated to cost in excess of $125,000. The company is capitalized at $350,000. George A. Sonricker, El Dorado, is engineer for the project.

Connecticut

SOUTH MANCHESTER—The Rogers Paper Mfg. Co. is planning for the rebuilding of the portion of its plant destroyed by fire, April 14, caused by an explosion.

Delaware

WILMINGTON—The Electric Hose & Rubber Co., 12th St., manufacturer of rubber hose, has awarded a contract to John E. Healy & Sons, 707 Tatnall St., for the erection of a 1-story addition, 57 x 90 ft., to be equipped as a pressing department. C. D. Garretson is general manager.

Florida

MIAMI—The Moore Haven Sugar Corp. has awarded a contract to the L. R. Steel Corp., Atlanta, Ga., for extensions and improvements in its mills at Moore Haven. A large part of the plant will be remodeled and considerable machinery installed. The present work is estimated to cost about $350,000, and will be supplemented by other improvements and additions at a later date to cost a like sum. John C. Grambling is secretary and treasurer.

BUNNELL—The Pidcock-Roberts Co., recently organized, is planning for the development of ocher and sienna properties in this section. It is proposed to install a complete washing plant and other operating machinery. J. N. Pidcock is president, and D. B. Roberts secretary-treasurer and general manager.

Illinois

CHICAGO—The Scientific Oil Co. plans the erection of a $10,000 building at 1645 South Kilbourne Ave. as addition to existing plant.

Indiana

INDIANAPOLIS—The Henry Furnace & Foundry Co., 915 North Davidson St., has preliminary plans under way for the erection of a new 1- and 2-story plant on Massachusetts Ave., to cost about $100,000. It is expected to call for bids some time in June.

RUSHVILLE—The Dill Foundry Co. is arranging plans for a 3-story plant addition, 40 x 100 ft., estimated to cost about $40,000. William Dill is secretary and treasurer.

Louisiana

ST. ROSE—The Petroleum Export & Import Co. has awarded a contract to H. P. Farnsworth, St. Charles St., New Orleans, La. for the erection of a number of new buildings for its oil works. Five buildings will be erected, including a barrel-filling plant, 60 x 250 ft.; canning plant, 60 x 175 ft.; power plant, 40 x 70 ft., pumping plant, 60 x 90 ft., and boiler plant. The company is a subsidiary of the Carson Oil Co., 29 South La Salle St., Chicago, Ill., of which Edward B. Carson is president.

MARRERO—The J. S. Long Co., manufacturer of soap products, is planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about $100,000 including machinery.

Maryland

HAGERSTOWN—The Maryland Fiber Products Co., recently incorporated with a capital of $150,000, is planning the establishment of a local plant for the manufacture of fiber specialties, including boxes containers, etc. Mark H. Landis, manager of the Landis Engineering & Mfg. Co., Ringgold St., Waynesboro, Pa., is head of the new company. Richard G. Stevenson and Thomas M. Cunningham, Hagerstown, are directors.

CUMBERLAND—The Potomac Glass Mfg. Co., is planning for the rebuilding of the portion of its plant, recently damaged by fire.

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York, is completing plans for two new buildings to be erected at its local refining plant at Woodall and Clement Sts. The structures will comprise a 9-story manufacturing plant, 140 x 320 ft., and 7-story pan house, 80 x 154 ft., both of steel and reinforced concrete. The entire plant is estimated to cost in excess of $5,000,000.

BALTIMORE—The new paper mill to be erected by the Gwynn's Falls Paper Co., 517 Equitable Bldg., at Gwynn's Falls, will comprise a main 1-story building and a number of smaller structures, estimated to cost about $250,000 with machinery. The company has recently filed articles of incorporation with a capital of $600,000. George W. Davis is head. Joseph H. Wallace, 5 Beekman St., New York, is engineer for the project.

Massachusetts

WALTHAM—The O'Hara Waltham Dial Co., Rumford Ave., has broken ground for the erection of the proposed 1-story addition to its watch dial manufacturing plant, 50 x 65 ft., to cost about $15,000. L. J. Geoffrion, 12 Howard St., has the building contract. Eliot O'Hara is head.

New Jersey

NEWARK—The Paragon Tannery Co., a new organization, has leased a portion of the plant of the Universal Caster & Foundry Co., 106-26 Adams St., near Ferry St., totaling about 35,000 sq.ft. of space, for the establishment of a new tanning plant for shoe and glove leather. Possession will be taken at once and it is proposed to have the plant ready for service at an early date.

JERSEY CITY—The Richard Chemical Co., Warren St., has taken bids for the construction of a 4-story brick addition, 50 x 54 ft., estimated to cost close to $40,000.

New York

NORTH TONAWANDA—The Earl R. Maltby Co., Ellicott Sq., Buffalo, has awarded a contract to Morris & Allen, Prudential Bldg., Buffalo, for the erection of the first unit of its proposed new plant at North Tonawanda for the manufacture of paper roofing products. The factory will be 1-story, 100 x 130 ft.; construction will be inaugurated at once.

BUFFALO — The Climax Compression Tube Co. of New York, Inc., 200 Cherry St., manufacturer of rubber tubes, etc., is planning the establishment of a new branch plant in this section. Negotiations are under way for the purchase of an existing works, to be equipped immediately for production. To finance the proposed expansion, the company has arranged for a stock issue of $1,000,000, and a large portion of the proceeds will be used for machinery and equipment. A. L. Case is chairman of the board.

Michigan

DETROIT—The Jeffrey-DeWitt Co., Butler Ave., manufacturer of spark plug porcelain, laboratory porcelain products, etc., is completing plans for the erection of its proposed new 5-story and basement plant at Hamtramck, to be reinforced concrete and estimated to cost about $200,000 with machinery.

DETROIT—The General Spring & Wire Co., 1930 Marston Ave., will take bids about the middle of May for the erection of a new 1-story plant, 200 x 250 ft., to cost about $175,000 with equipment. A power house will also be constructed. C. L. Clerk is secretary, Edward D. Shank.

38 South Dearborn St., Chicago, Ill., is architect.

Ohio

NORWALK—The Pioneer Rubber Co. has completed plans for the erection of its proposed new 2-story and basement plant, 40 x 80 ft., estimated to cost about $30,000. B. G. Smith is head.

TOLEDO—The Standard Oil Co. has completed the erection of its new Bay Shore refinery and production has been inaugurated. The plant consists of a total of 100 stills and the different units will be placed in service as fast as possible. The plant represents an investment of close to $15,000,000.

COLUMBUS—The Board of Trustees, Ohio State University, is taking bids up to May 3 for the erection of a 1-story addition to the chemistry building, to 205 x 298 ft., and estimated to cost about $275,000. Joseph N. Bradford, Brown Hall, State University Campus, is supervising architect.

Pennsylvania

CHARLEROI—The Electric Alloy Steel Co., manufacturer of high-speed tool steel, is completing the installation of a new electric furnace, giving the plant two 6-ton electric furnaces and one crucible furnace with an aggregate capacity of 55 tons every 24 hours. Plans are under way for the installation of another 3-ton electric furnace at a later date.

MARCUS HOOK—The Union Petroleum Co., 17 Battery Pl., New York, is reported to have plans under way for the erection of the initial units of its proposed new oil refinery on property at Marcus Hook recently acquired. The site totals about 200 acres of land. The entire plant is estimated to cost in excess of $5,000,000. The company is a subsidiary of the Sinclair Consolidated Oil Co., 120 B'way.

MACUNGIE, PA.—J. G. Wieder, manufacturer of paper boxes and containers, is said to be planning for the erection of an addition to his plant, with the installation of new machinery.

Texas

SAN ANTONIO — The International Petroleum Co. has commenced work on the completion of its new local oil refinery, and plans for occupancy and operation at an early date. A. A. Ash is secretary.

HOUSTON—The Madison Coal & Oil Co., recently organized with a capital of $3,000,000, has plans under way for the erection of a new plant in the vicinity of Navasota, Tex., for the manufacture of coal briquets. The plant will include an extensive byproducts department for the production of carbonized briquets, and the recovery of fuel oil, ammonium sulphate, pitch, tar and other chemical products. The initial plant will have a capacity of about 30 tons of briquets per hour. David M. Duller, Houston, is engineer for the company.

FORT WORTH—The Fort Worth Envelope Co., 610 West Daggett St., recently organized, has plans under way for the installation of new machinery in a local plant building for the manufacture of envelopes and other paper specialties. It is proposed to develop an output of about 250,000 envelopes per day. John A. Stafford is president, and W. C. Lowden secretary.

SOUTH BEND—The Graham Oil & Refining Co., Graham, Tex., has commenced the erection of its proposed new gasoline refinery at South Bend, and plans to have the plant ready for service at an early date. It will have an initial capacity of 1,000 bbl.

DALLAS—The Trinity Paper Mill has preliminary plans under way for the erection of a new paper pulp mill in the vicinity of McKinney, Tex. The company recently acquired the plant of the Collins County Mill & Elevator Co., near McKinney.

Virginia

RICHMOND—The Jerry Bros. Belting Co., 1823 East Main St., manufacturer of leather belting, has plans completed for the erection of an addition to its plant to cost about $25,000. Considerable machinery will be installed, including trimming and finishing machines presses, etc. George Gassman is manager.

West Virginia

MORGANTOWN—The United States Sheet & Window Glass Co. is reported to be planning for extensions in its local plant, to include the installation of new machinery. The company recently filed articles of incorporation with a capital of $4,000,000. Walter A. Jones is head.

Capital Increases, Etc.

THE ROCKWOOD SILICA CO., Rockwood, Mich., has filed notice of increase in capital from $250,000 to $375,000.

THE SARGENT PAINT CO., Indianapolis, Ind., has filed notice of change of name to the Sargent-Gerke Co.

THE EMPIRE PAINT CO., Indianapolis, Ind., has filed notice of change of name to the Sargent-Gerke Co.

THE EMPIRE ORNAMENTAL GLASS CO., 437 Washington St., New York, N. Y., has filed notice of increase in capital from $15,000 to $50,000.

THE BELLEVILLE COMMERCIAL FOUNDRY Co., Belleville, Ill., has filed notice of increase in capital from $25,000 to $60,000.

THE D. & C. OIL CO., Bridgeport, Conn., has filed notice of increase in capital to $50,000.

THE NEW ERA PROCESS CORK CO., New York, N. Y., has filed notice of increase in capital from $500,000 to $750,000.

THE COSMUS CHEMICAL CO., Muncie, Ind., has filed notice of dissolution under state laws.

THE WOLVERINE GLASS CO., Saginaw, Mich., has filed notice of increase in capital from $125,000 to $150,000.

THE PACIFIC BONE & FERTILIZER CO., American National Bank Bldg., San Francisco, Cal., has filed notice of increase in capital to $300,000.

New Companies

THE FEDERAL LIGHT & REFINING CO., Newark, N. J., has been incorporated with a capital of $200,000 to manufacture gas mantles and kindred products. The incorporators are Clarence B. White, Ambrose J. Walsh and James H. Krieck, 122 Commerce St.

THE CONCORD SMELTING & REFINING CO., Boston, Mass., has been incorporated with a capital of $50,000 to manufacture refined metal products. The incorporators are Samuel Friedman, Boston; Bernard M. Edinberg, Roxbury, Mass. and Nathan Kositsky, Concord, Mass.

THE ELECTRO CHEMICAL REFINERIES, INC., 29 South La Salle St., Chicago, Ill., has been incorporated with a nominal capital to manufacture chemical products. The incorporators are A. M. Johnson, Burton P. Sears and Kenneth Mullins.

THE LAFAYETTE PAPER CO., New York, N. Y., has been incorporated with a capital of $20,000 to manufacture paper goods. The incorporators are R. Robins, M. Wallach and A. A. Cohen. L. M. Feinberg, 44 Court St., Brooklyn, represents the company.

THE HOLMES CHEMICAL CO., Elizabeth, N. J., has been incorporated with a capital of $25,000 to manufacture chemicals and chemical byproducts. The incorporators are Herbert E. Manvel, Judson H. Sencindiver, New York; and Irving J. Denton, South Orange, N. J.

THE CHARLES L. RICHARDSON CO., Boston, Mass., has been incorporated with a capital of $10,000 to manufacture chemical products, drugs, etc. The incorporators are Charles A. Vail, M. T. Allen and C. M. Hollander, 37 Leverett St.

THE LANCASTER MIDWAY OIL CO., Whittier, Cal., has been incorporated with a capital of $250,000 to manufacture petroleum products. The incorporators are P. H. Porter, Ray Steele and W. F. Dilts, all of Whittier.

THE PAUL RUBBER CO., Salisbury, N. C., has been incorporated with a capital of $250,000 to manufacture rubber products. The incorporators are M. L. Miller, W. J. Daniel and E. C. Brainard, Salisbury.

THE ANDREW RAGONE CO., New York, N. Y., has been incorporated with a capital of $100,000 to manufacture paper products. The incorporators are G. J. Russell, D. R. Cavalla and W. A. Wight, 41 Park Row.

THE ELLICOTT PAINT CO., Buffalo, N. Y., has been incorporated with a capital of $50,000 to manufacture paints, oils, etc. The incorporators are C. H. Nagel, G. G. Allen and E. G. Guenther. Kellogg, Babcock & Sullivan, Buffalo, represent the company.

THE MURPHY-MILES OIL CO., Room 1843, 122 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of $20,000 to manufacture oil products. The incorporators are Robert P. Lonergan, Everett Miles and Clement J. Murphy.

THE STORER RUBBER CO., Boston, Mass., has been incorporated with a capital of $200,000 to manufacture rubber products. Fred E. Storer, 26 Fellsway, West, Somerville, Mass., is president and treasurer: Walter R. Storer and F. E. Barnes are directors.

THE STANDARD PAPER BOX CO., Detroit, Mich., has been organized to manufacture paper boxes and containers. George E. Watson and Edward C. Parker, 888 Delaware St., heads the company.

THE SCHERMULY POLARIZATOR CORP., New York, N. Y., has been incorporated with an active capital of $20,000 to manufacture coal oil products. The incorporators are J. H. Klein, A. B. Brenner and S. Bachrach. Vanvorst, Marshall & Smith, 25 Broad St., represent the company.

C. S. LITTELL & CO., INC., New York, N. Y., has been incorporated with a capital of $200,000 to manufacture chemicals and chemical byproducts. The incorporators are C. S. Littell, T. W. Day and C. C. Bruen, Greene & Hurd, 43 Exchange Pl., represent the company.

THE PYRO-REM CHEMICAL CO., 801 West Ninth St., Los Angeles, Cal., has filed notice of organization to manufacture chemical products. John J. Nesom, 125 West Elk St., Glendale, Cal., heads the company.

THE NITRO CHEMICAL CO., Nitro, W. Va., has been incorporated with a capital of $50,000 to manufacture chemicals and chemical byproducts. The incorporators are W. D. Payne, Berkeley Minor, Jr., and C. P. Miller, Charleston, W. Va.

THE W. J. READY BRICK CO., Richmond, Va., has been incorporated with a capital of $50,000 to manufacture bricks and other burned clay products. The incorporators are W. J. Ready and W. J. Crump, Richmond.

GEORGE F. BASSETT & CO., East Orange, N. J., has been incorporated with a capital of $150,000 to manufacture china products. The incorporators are E. Holbrook, William B. and W. Irving Harris, East Orange.

THE SMITH-BEYER PAPER CO., Los Angeles, Cal., has been incorporated with a capital of $100,000 to manufacture and deal in paper products. The incorporators are W. B. Smith, William Chanin and J. E. Mahon, all of Los Angeles.

RADIATED BEARINGS, INC., 127 North Dearborn St., Chicago, Ill., has been incorporated with a capital of $100,000 to manufacture steel bearings, etc. The incorporators are A. A. and A. M. McClanahan, and Walter J. Dukes.

THE MACK PAINT PRODUCTS CO., Pittsburgh, Pa., has been incorporated with a capital of $10,000 to manufacture paints, oils, etc. The incorporators are E. G. and R. L. McNamara, and L. Van Buren, Pittsburgh.

THE HOPEKO SUPPLY CORP., Rochester, N. Y., has been incorporated with a capital of $100,000 to manufacture refined oil products. The incorporators are A. A. Hopeman, M. W. Hogle and F. S. Gould, Rochester.

THE MINIT PRODUCTS CO., Buffalo, N. Y., has been incorporated with a capital of $150,000 to manufacture soap and kindred products. The incorporators are C. Whitney, J. Kaufman and A. Fybush.

THE MID-WEST DRUG & CHEMICAL CO., 1539 West Polk St., Chicago, Ill., has been organized to manufacture chemicals, drugs, etc. The company is headed by Louis Schiavone and Peter J. Spingola.

THE VITAMINE CO. OF AMERICA, INC., Jersey City, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Harry C. Hand, Robert M. Gavett and James S. Lindsay, 15 Exchange Pl.

THE WINSTON-SALEM PAINT CO., Greenville, S. C., has been incorporated with a capital of $10,000 to manufacture and deal in paints, oils, etc. J. L. Carson is president, and J. B. Jenkins secretary and treasurer.

THE KADIUM LABORATORIES, INC., New York N. Y., has been incorporated with a capital of $350,000 to manufacture chemicals and chemical byproducts. The incorporators are C. J. Dolan, J. H. Kaesen and A. C. B. McNevin, 31 Nassau St.

THE FER-SUL CHEMICAL CORP., Fredericksburg, Va., has been incorporated with a capital of $1,250,000 to manufacture chemicals and affiliated products. The incorporators are Paul H. Brattain and E. W. Black, both of Washington, D. C.

THE ANTHONY OIL CO., Los Angeles, Cal., has been incorporated with a capital of $250,000 to manufacture petroleum products. The incorporators are C. G. Anthony, H. D. Laughlin and D. M. Sutherland, all of Los Angeles. The company is represented by B. J. Bradner, 911 Wright & Callender Bldg.

THE NEW MILFORD CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture chemicals and chemical byproducts. The incorporators are P. Cifini, J. Mazza and F. Ballerini. The company is represented by Ryan, Hefferman & Dawn, 25 West 45th St.

THE STANDARD POURED BRICK CO., Miami, Fla., has been incorporated with a capital of $100,000 to manufacture cement brick and kindred specialties. The incorporators are L. R. Nordquist and J. L. Holmberg, Miami.

Coming Meetings and Events

AMERICAN ASSOCIATION OF ENGINEERS will hold its seventh annual convention at the Hotel Lafayette, Buffalo, N. Y., on May 9, 10 and 11.

AMERICAN CHEMICAL SOCIETY is holding its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters are at the Hotel Rochester.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY will hold its annual meeting April 27 to 30 in the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month; except June, July, August and September.

TANNERS' COUNCIL OF THE UNITED STATES will hold its annual spring convention at the Hotel Traymore, Atlantic City, May 5 and 6.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.